Commencement Bay Cumulative Impact Study

Historic Review of Special Aquatic Sites

Document prepared for:

U.S. Army Corps of Engineers
4735 E. Marginal Way South
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19 ABSTRACT

A primary-level literature review of the extent and location of special aquatic sites in and around Commencement Bay area has been completed. Sources included those readily available in libraries, universities, agencies, dated newspapers, city and county records, and organizations. Knowledgeable individuals, agency personnel, tribal sources, scientists, and historians were consulted. Seven Historic Periods were identified, described, and analyzed, ranging from 1877 to the present with an emphasis on the period between 1877 and 1941. Geographical Information Systems (GIS) maps were produced for endpoints of each Historic Period and documented dredge and fill activities were identified and located on these maps with Arc/Info information concerning specific details of volumes or areal extent of coverage, applicant, and date of activity.

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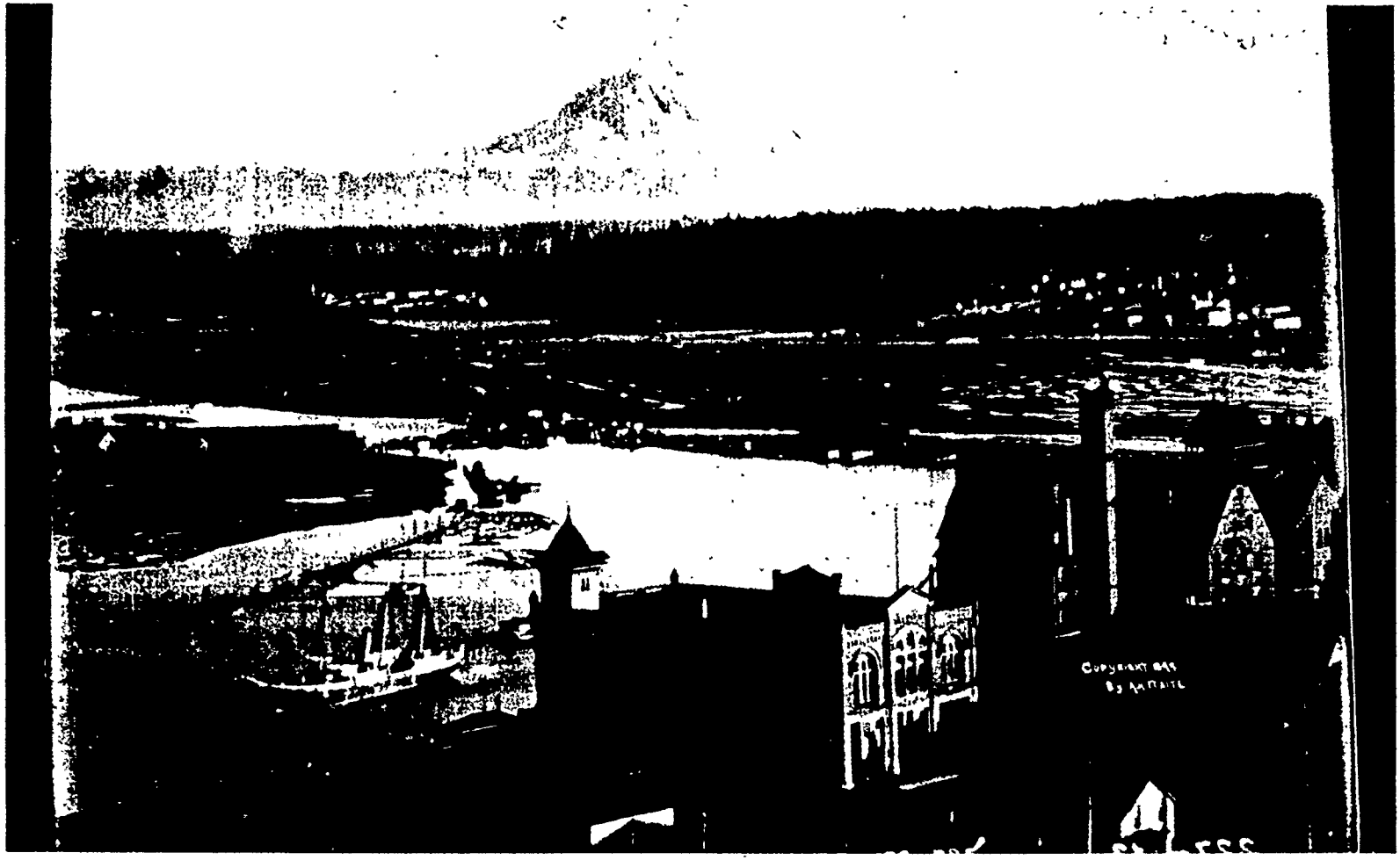

EXECUTIVE SUMMARY

A primary-level literature review of the extent and location of special aquatic sites in and around Commencement Bay area has been completed. Sources included those readily available in libraries, universities, agencies, dated newspapers, city and county records, and organizations. Knowledgeable individuals, agency personnel, tribal sources, scientists, and historians were consulted. Seven Historic Periods were identified, described, and analyzed, ranging from 1877 to the present with an emphasis on the period between 1877 and 1941. Geographical Information Systems (GIS) maps were produced for endpoints of each Historic Period and documented dredge and fill activities were identified and located on these maps with Arc/Info information concerning specific details of volumes or areal extent of coverage, applicant, and date of activity.

The special aquatic sites investigated included vegetated shallows, intertidal mudflats, and wetlands. Vegetated shallows (eelgrass beds) are generally scarce in the area, and references to several locations were verified totalling 91 acres. Of an estimated 2,085 acres of intertidal mudflats presumed present in 1877, about 187 acres remain, a loss of 89%. An estimated 3,894 acres of emergent marsh habitat once occurred in a wide band between the MHHW level and the present location of Interstate 5. Of this habitat, an estimated 57 acres or 1% remain, much of which is probably not original habitat. Most of the habitat loss was a direct result of intentional filling for port development, flood control, and agricultural use. Marsh habitat also changed from an original salt/brackish marsh to a degraded brackish/freshwater marsh before being almost completely filled. Recent Corps permits have been studied for information concerning types and extent of mitigation that was undertaken or required as part of the permit process. With the exception of large-scale projects such as the Milwaukee Waterway Fill Project, detailed information is generally scanty or lacking.

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1.0 INTRODUCTION

1.1 Background

The Commencement Bay Nearshore/Tideflats area, of which Commencement Bay is a part, has been designated by the Environmental Protection Agency (EPA) as a Superfund site. Decades of development in and around Commencement Bay have resulted in significant shoreline alterations, loss of substantial aquatic, mudflat and delta wetland habitat, and degradation of water quality. Dredging of nearshore areas to support port and harbor facilities for the Port of Tacoma has been carried out since the turn of the century by public and private industry. Areas south of the waterways have been diked, filled, and channelized for construction of storage buildings, shipping facilities, and various commercial and industrial purposes. Continued development pressures, maintenance dredging, and other activities necessitate an evaluation of the cumulative impacts of such activities on the remaining aquatic sites of Commencement Bay.

Appendices A and B (Section 9.0) present the listing of Trustees involved in the Comprehensive Habitat Mitigation and Restoration Plan for Commencement Bay, and the original US Army Corps of Engineers Statement of Work: Commencement Bay Cumulative Impact Study, Historical Review of Special Aquatic Sites. The latter document specifies tasks to be completed under this contract.

Pursuant to Section 10 (1899) of the Rivers and Harbors Act and Section 404 (1973) of the Clean Water Act, the U.S. Army Corps of Engineers (Corps) regulates the dredge and discharge of fill or dredge material into waters of the United States. The 404(b)(1) Guidelines require that such activities must not adversely affect the aquatic ecosystem. Included in these guidelines is the assessment of immediate and historic cumulative impacts to "special aquatic sites" which are defined as mudflats, vegetated shallows, and wetlands.

1.2 Purpose

Various resource agency and tribal recommendations resulted in the Commencement Bay Cumulative Impact Study, which was designed to produce the most complete historic record documenting loss of special aquatic sites. The baseline information will be used to quantify the cumulative impacts beginning in the mid-1800's through 1941 as a management tool for use by permitting agencies. This goal involves a team effort including the EPA, U.S. Fish

(to pg 2)

and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), Department of Natural Resources (DNR), and the Corps. As part of the Corps role, David Evans and Associates, Inc. (DEA) presents the historical map review of the special aquatic sites and shoreline development during specific time intervals reported above (Appendix B).

A comprehensive primary-source literature and archival search was conducted to identify historical maps that could be used to define the locations and extent of special aquatic sites in Commencement Bay. In addition to several types of maps, other materials that were reviewed consisted of photographs, aerial photographs, newspapers, reports, and personal communications. Diaries and anecdotal evidence were only used if easily acquired.

The historical narrative includes a cursory discussion of the period from the earliest aerial photographs to the present; however, the major focus was on identification of habitat sites prior to the earliest useable aerial photographs. Trends in the dredging and filling of special aquatic sites were identified and assessed for each specific time interval.

Since the EPA will be investigating the specific areal extent of special aquatic site loss from 1941 to the present, maps and photographs dating from the earliest known records to 1941 are emphasized in this study. The locations of special aquatic sites were transferred and mapped in Geographical Information Systems (GIS) format using Arc/Info software. Corps regulatory branch files were analyzed to determine the extent of dredging and filling in Commencement Bay since 1972, and to identify how these activities were ameliorated through mitigation.

(cont)

1.3 Study Area

Commencement Bay is generally defined as a geographic region of south Puget Sound in Washington State extending from Brown's Point to Point Defiance (Figure 1). It provides a natural harbor for ships because there are no bars or other obstructions at the entrance to the Bay. The waters are deep throughout the entire Bay, ranging from 540 feet at the entrance to approximately 75 feet at the head of the Bay. The waters shoal abruptly here to mud flats that are exposed at low water (U.S. Board, 1925). Besides the marine water influence from Puget Sound there is significant freshwater input into the Bay from the inlands to the south. The Hylebos and Wapato Creeks and the Puyallup River all contribute considerable flows to the Bay and simultaneously a proportionate amount of sediment load.

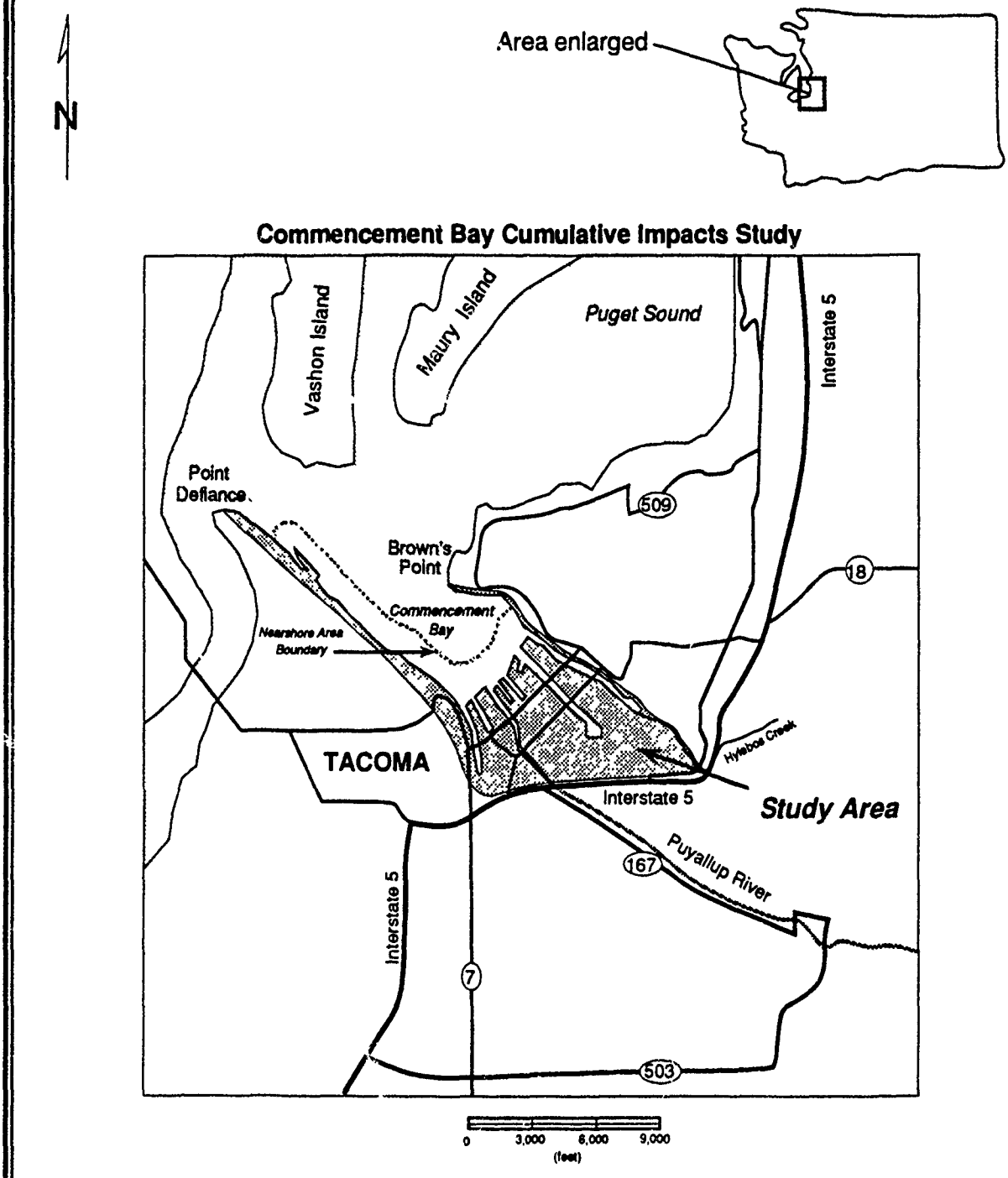

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Figure 1. Study Area Map

For the purposes of this study, areas north of Interstate 5 are included in the study area, with emphasis on the Tacoma Harbor.

1.4 Prior Research

Significant attention has been given to the Commencement Bay area in the last decade. For the Seattle District of the Corps, Dames and Moore (1981) published a seven-volume baseline study and evaluation for a Commencement Bay Study/Environmental Impact Assessment. Contained in these volumes are descriptions of the physical settings and characteristics such as geology, soils, hydrology, and climate (Dames and Moore, 1981). In 1987 the Puget Sound Environmental Atlas was produced under funding from the Seattle District Corps of Engineers, EPA, and the Puget Sound Water Quality Authority (Evans-Hamilton, 1987). Included in this two volume set are maps depicting the locations of various types of aquatic communities, such as eelgrass bed locations.

A similar, albeit smaller, study was undertaken in the Duwamish River estuary which discussed changes in habitat over time (Blomberg et al., 1988). This study divided the historic period into sections, and discussed overall habitat loss resulting from human development activities.

Other historical studies that dealt specifically with habitat assessment and feasibility studies in the Commencement Bay area include reports by Hart Crowser and Associates (1975), Unites States Fish and Wildlife Service (1979), Bortleson, et al. (1980), and Tetra Tech (1985 and 1988).

2.0 RESEARCH METHODS

The overall purpose of this study was to document and map where possible, changes in special aquatic sites occurring in Commencement Bay, to as early a date as possible. As per the Section 404(b)(1) Guidelines, and for the purposes of this study, the special aquatic sites were delineated into three classes: mudflats (broad flat areas along the sea coast and in coastal rivers to the head of tidal influence - intertidal areas); vegetated shallows (permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as eelgrass beds and turtle grass in estuarine or marine systems); and wetlands (areas that are inundated or saturated by surface or ground water

at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions - emphasizing estuarine and palustrine systems). These three types of special aquatic sites were selected because they are regulated under Section 404 of the Clean Water Act.

A literature, map, and photograph search was conducted to locate and collect all information relevant to determining the project objective. Seattle District Corps permit files were included in this search, and previous mitigation efforts were especially noted. The search focused on the period prior to the earliest useable aerial photographs (1941), since the time period from 1941 to the present is being undertaken by the EPA under a separate contract. The data collected ranges from about 1850 to the present with emphasis being on the period from 1877 to 1941.

The special aquatic and mitigation sites identified through the literature review process were digitized onto existing GIS database maps. For a relative understanding of the changes in the special aquatic sites, dredging and filling activities, and mitigation efforts, the project years were divided into seven historic time periods. These were selected based upon published landmark maps (i.e., U.S. Geological Survey topographic maps or other accurate representational maps) coupled with relatively active periods of shoreline alteration.

2.1 Literature Review

The literature search included the University of Washington Library Special Collections, University of Puget Sound, City of Tacoma, Port of Tacoma, Tacoma Public Library, Washington State Historical Society (Tacoma), the Corps Regulatory Branch files, the Puyallup Indian Tribe, The Museum of History and Industry (Seattle), the National Archives, newspapers, survey records, maps, and other documents.

Forty-two person-days were needed to research consistent information pertaining to habitat types, waterway development, industry evolution and associated by-products, etc. in Commencement Bay. When such information was extracted it was verified and/or compared with other sources. Information was compiled, tabulated, and due to the scarcity of sequential, verifiable information, cross-referenced with other sources whenever possible. For example, many of the newspaper articles depicting the Port of Tacoma were either somewhat stylized or showed proposed activities. Occasionally, plat maps indicated lots and

streets on the mudflats prior to any development in these areas. Discrepancies in maps and other sources required numerous revisions of the historical sequence.

Knowledgeable individuals from the University of Washington, University of Puget Sound, Department of Natural Resources, Washington Historical Society, and local consultants in specialized fields were interviewed. Section 7.0 presents a complete listing of sources consulted. Section 8.0 presents the references cited in the text.

2.2 Graphical and Numerical Analysis

Dates, dimensions, and other numerical data were transferred directly from the references to the tables. Tabulation for area of dredge or fill volumes was computed on a calculator and rounded off to one decimal place. The maps were reproduced (through GIS) exactly as printed except for features which were documented as either proposals for the future or as engineering concepts that did not materialize.

Discrepancies in the values in the Summary Tables given at the end of each Section are largely because historically reported activities were predominantly dredge events. Dredge amounts are given or were calculated as volumes. Aerial photographs and maps display filled areas as surface areal extent. Thus, when 100,000 cubic yards of material were excavated for waterways construction, the amount of land surface area impacted is extremely difficult if not impossible to assess. Losses include original mudflat habitat as well as those areas where the dredge material was deposited. Values in the Summary Tables then do not necessarily total the end column result.

2.3 Mapping (Geographical Information System)

The Commencement Bay project data and displays were created using the automated geographic information system (GIS) Arc/Info. Arc/Info is computer software that is used to automate, manipulate, analyze, display, and store geographic data in digital form. Arc/Info organizes geographic data using a relational database management system (INFO) to store information about the mapped features and uses a graphic manipulation package (ARC) to spatially analyze and visually display the mapped data.

The functions performed by a geographic information system fall into these four broad categories:

1) Input,
2) Analysis,
3) Data Management, and
4) Display and Conversion.

Input includes such functions as digitizing, editing, and reformatting data. The purpose of the input operation is to take data, and convert it into a form usable by Arc/Info. Supported methods for data input into Arc/Info include digitizing, scanning, use of coordinate geometry, and converting data from other formats compatible with Arc/Info.

Analysis includes such functions as topological overlay, length of arcs, area calculations, and modeling. Analysis operations examine the data with the intent to extract or create new data that fulfills some required condition or conditions of the selected coverage/coverages.

Data management is the handling of large sets of digital geographic or cartographic data. Management operations oversee the storage and retrieval of this data in a consistent and convenient form. This often requires that the data be organized into a relational database.

Display and conversion includes all operations that produce graphic output and reports, such as maps and color displays drawn using pen plotters or other peripheral devices. Formatted reports of tabular information are generated using various data queries.

The following is a brief description of the manner in which the GIS has been applied to this project.

2.3.1 Data Input

The primary map data input method used for the Commencement Bay study was digitizing. The GIS database has been developed from a variety of historical materials depicting shorelines, hydrography, roads, and other features. Information digitized from these sources was digitized in the Universal Transverse Mercator (UTM) coordinate system. A simple procedure for establishing the digitizing environment was followed for the maps which were well-annotated with either latitude/longitude or UTM values. A more complicated procedure was employed for map sources that did not have annotated coordinate control points.

Establishing the digitizing environment for well-controlled map sources was performed either by using points annotated with either UTM coordinates or latitude/longitude. The latitude/longitude locations were transformed into UTM values prior to initialization of the digitizing environment. This was performed using the Arc/Info command PROJECT. Subsequent digitizing sessions were initiated using the UTM values of these known locations. Once a well-controlled map was initialized in the digitizing environment, UTM values for any point on that map could be derived.

Uncontrolled maps (i.e. maps without latitude/longitude or UTM registration points) were set-up for digitizing through the process of identifying points they had in common with the controlled maps. Once these common points were identified (e.g. section corners, pier corners), they were digitized on the previously controlled maps to derive the UTM values for the points. These points were then used to initialize the digitizing environment for the uncontrolled maps.

2.3.2 Data Analysis

Analysis performed on Commencement Bay included calculations of wetland and fill areas for the selected Historic Periods. Lengths of roads and railroads were also calculated using Arc/Info. Tables were generated directly from the Arc/Info database.

2.3.3 Database Management

The informational database for the maps was developed in the standard Arc/Info method using the PAT and AAT files. A single cover of the area was developed with attributes assigned to each feature for each survey year. In this way, plots and summary tables for each year may be called up separately (i.e. coastline changes, wetland areas, areas of fill). The summary tables provided in this report were used directly as the database in the Arc/Info format.

2.3.4 Display

Once the database was fully developed, maps were created on a pen plotter. The standard map scale utilized for presentation purposes was 1:24000. A series of plots were created with areas shaded to portray changes in land cover and land use through the course of the

study years. The manner of display enables various changes to be evaluated at will. The benefits of these relatively simple changes form the basis for using GIS.

2.4 Mitigation Analysis

As part of the mitigation site analysis, a review of fill and dredge permits issued by the Corps for work in Commencement Bay from 1972 to the present was conducted to identify the locations of wetland changes. A total of 212 permits were selected by the Corps personnel, however 20 of these were unavailable for review because they could not be located. Limits of study included any excavated waterways along the southeastern shore of the Bay, the Puyallup River, or jurisdictional wetlands in the Commencement Bay area. General permit information compiled and tabulated included applicant name, permit number, effective date of permit, location of activity, nature and reason for work, and any proposed mitigation or special conditions of the permit.

Assessment of the files was conducted at Corps of Engineers Regulatory Division offices. A file summary form was developed by DEA to provide a framework and ensure consistency in the information gathered from each permit file. The file materials are arranged chronologically from back to front. Initially the files were reviewed from the oldest item in the file to the newest, in order to gain a thorough understanding of the contents and intent of the permit. The methodology was adjusted as it became apparent that beginning with the newest material was more efficient, because many files either had a letter advising the applicant of permit cancellation or had both the permit and site drawings near the front of the file. These two items typically provided all of the information to fulfill the intent of the search. Occasionally specific information on exact quantities of fill were not provided, and in these cases the summary forms were left somewhat vague, specifying only "fill" or "dredge" with no quantities.

A total of approximately 15 person-days were needed to review the files. This time included travel to and from the Corps offices and coordination with Corps personnel, as well as extracting information from the files. In addition, approximately 5 person-days were required to tabulate and assess the information which was done at the DEA office.

The assessment did not include detailed information on the reason given for the permit application. It was noted on the summary form, but by and large was not relevant to the project. Similarly, no effort was made to connect dredge sites with disposal sites unless the

two were clearly indicated on either the permit or the site drawings. Since most permits specified either upland disposal or deep water disposal, the information was not tracked. This resulted in approximately one million additional yards recorded as dredged from waterways than recorded as fill disposed at other sites.

3.0 FINDINGS

3.1 Presumed Original Condition of the Puyallup Delta

Reports from local historical experts, biologists, and evaluation of the earliest photographs and maps strongly suggest that in 1877 the area bound by mean lower low water (MLLW) and mean higher high water (MHHW) was totally intertidal mudflat (Hart Crowser, 1975; Bortleson, 1980; Morgan, 1991; Slip, 1991). The U.S. Fish and Wildlife Service would classify such wetland habitat as estuarine, intertidal, unconsolidated shore, mud, regularly flooded (E2US3N). According to maps (United States Department of the Interior 1884; Hart Crowser, 1975; Bortleson, 1980) this area encompassed approximately 1,829 acres. Typically devoid of emergent or vascular plants, this habitat probably maintained high populations of green algae.

Historically, vegetated shallows (specifically eelgrass beds) were apparently scarce to absent in most of the Bay at this time and thereafter (Thom, 1991). The high volumes of sediment deposited by the Puyallup River cause excess siltation which is not beneficial to eelgrass bed development. However, recent surveys by the Department of Natural Resources have confirmed several eelgrass beds within the study area (Mumford and Bailey, 1990) (Section 3.4.4.). These eelgrass beds would be classified as estuarine, intertidal, aquatic bed, rooted vascular (E2AB3).

Information gathered from Bortleson (1980) suggests that "subaerial marsh" [emergent marsh] covered about 2,471 acres of the Puyallup delta. However, information from Morgan (1991), Slip (1991), and assessment of typical marsh elevations in similar estuaries suggests that salt/brackish marsh extended from the mean higher high water level southeastward to the approximate location of present-day Interstate 5. Reasons for this decision are given in the Sections 3.2 and 3.3. This habitat would be classified as estuarine, intertidal, emergent, persistent (E2EM2).

3.2 Typical Estuarine Habitat Description

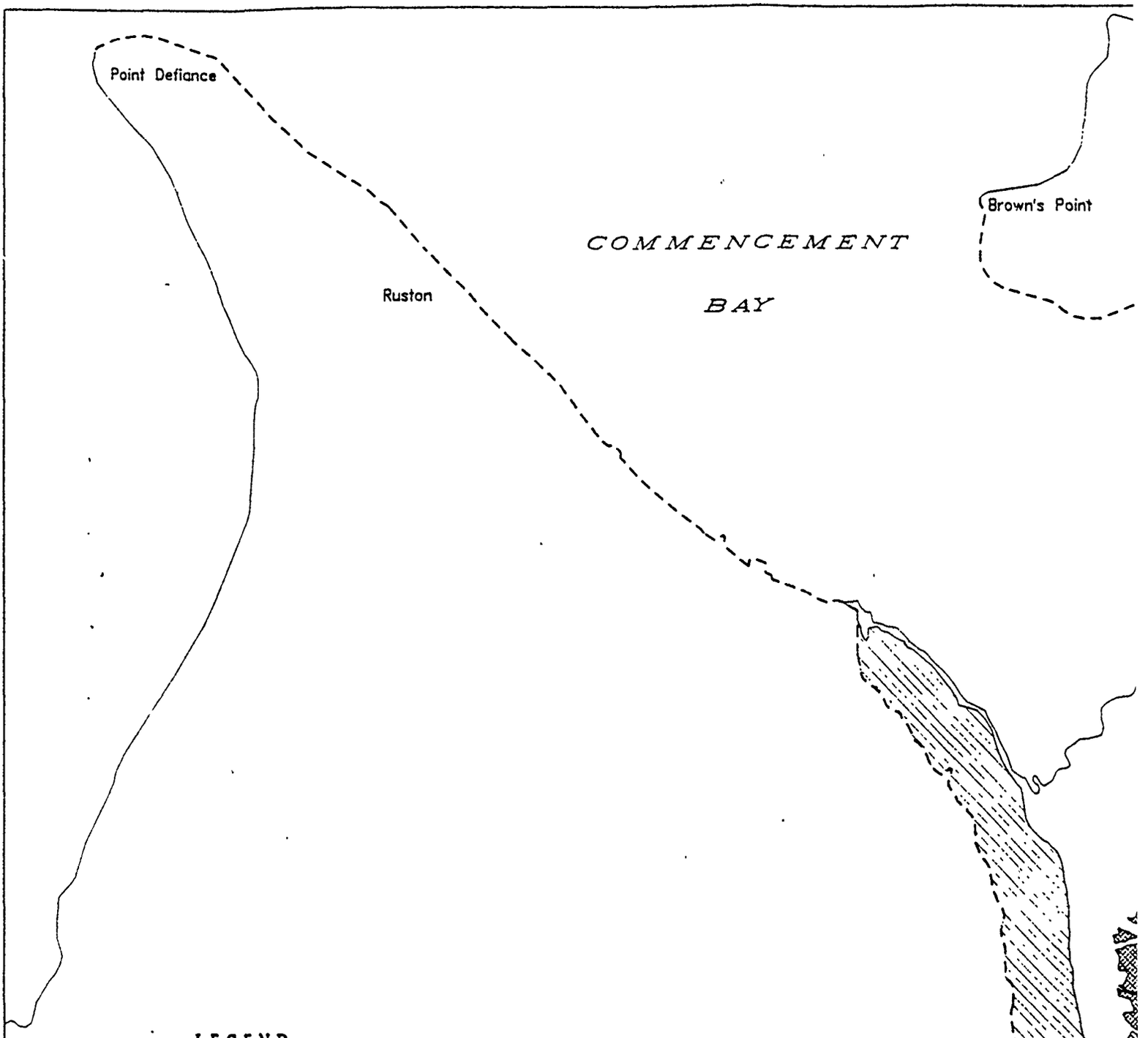
Typically the structure of west coast salt marshes changes as the elevation gradient increases. The boundary between intertidal mudflats and low salt marsh occurs near +4 feet (above mean sea level [MSL]). Low salt marsh vegetation includes pickleweed (*Salicornia* spp.), arrowgrass (*Triglochin maritimum*) and saltgrass (*Distichlis* spp.). These areas are exposed and flooded by tides daily. Around +6 feet high salt marsh occurs and includes bulrush or tule (*Scirpus* spp.), sedges (*Carex* spp.), and jaumea (*Jaumea carnosa*) in addition to the low salt marsh species. As distance from the intertidal area increases, the influx of freshwater reduces salinity and the marsh becomes brackish. The braiding, or dendritic pattern of channels and rivulets in such areas results in a complex of frequently exposed areas to areas flooded only during high tidal or flood events. In these areas brackish conditions remain in the channels and depending on the microtopographic relief, brackish to almost freshwater conditions may occur gradually as elevation increases on small hummocks. Species common to brackish conditions include bulrush or tule (*Scirpus* spp.) and on the higher areas, or hummocks, cattails (*Typha* spp.) may dominate the marsh (Faber, 1982).

3.3 Discussion of Presumed Original Conditions

The Commissioner Reports (Puyallup Indian Tribe, 1862-1915) described the intertidal mudflat area as the "Tacoma Tidelands". The area behind the mudflats was identified as Tidal Marsh. There is a high probability that tidelands extended upstream of the Tidal Marsh (Figures 2 and 3). The reports also state "*The* [Puyallup] *reservation consists in a great degree, of tide meadow, which is very seldom overflowed, and on which grow large crops of luxuriant grass.*"

"*Approximately 1,000 acres of tidelands existed inland from the straight line boundary until approximately 1940*" (Puyallup Indian Tribe, 1979). The "*straight line boundary*" was interpreted as a line that roughly coincided with the presence or absence of vegetation near the mudflats.

This "tide meadow" extended at least as far south as Fife (Section 1, Township 20 North, Range 3 East), which is near Interstate 5 (Milroy, 1873). Elevations in the region near Interstate 5 range from +10 to +12 feet above mean sea level, which is in accordance with the upper limit of tidal marshes. Soil Conservation Service maps dated from 1909 and 1939 indicate the majority of soils in the Puyallup delta region as Tacoma muck (tidelands) with



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Study Area Boundary
- Future Site of I-5

N

1877 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	2085
Intertidal Emergent Marsh	2539
	4624

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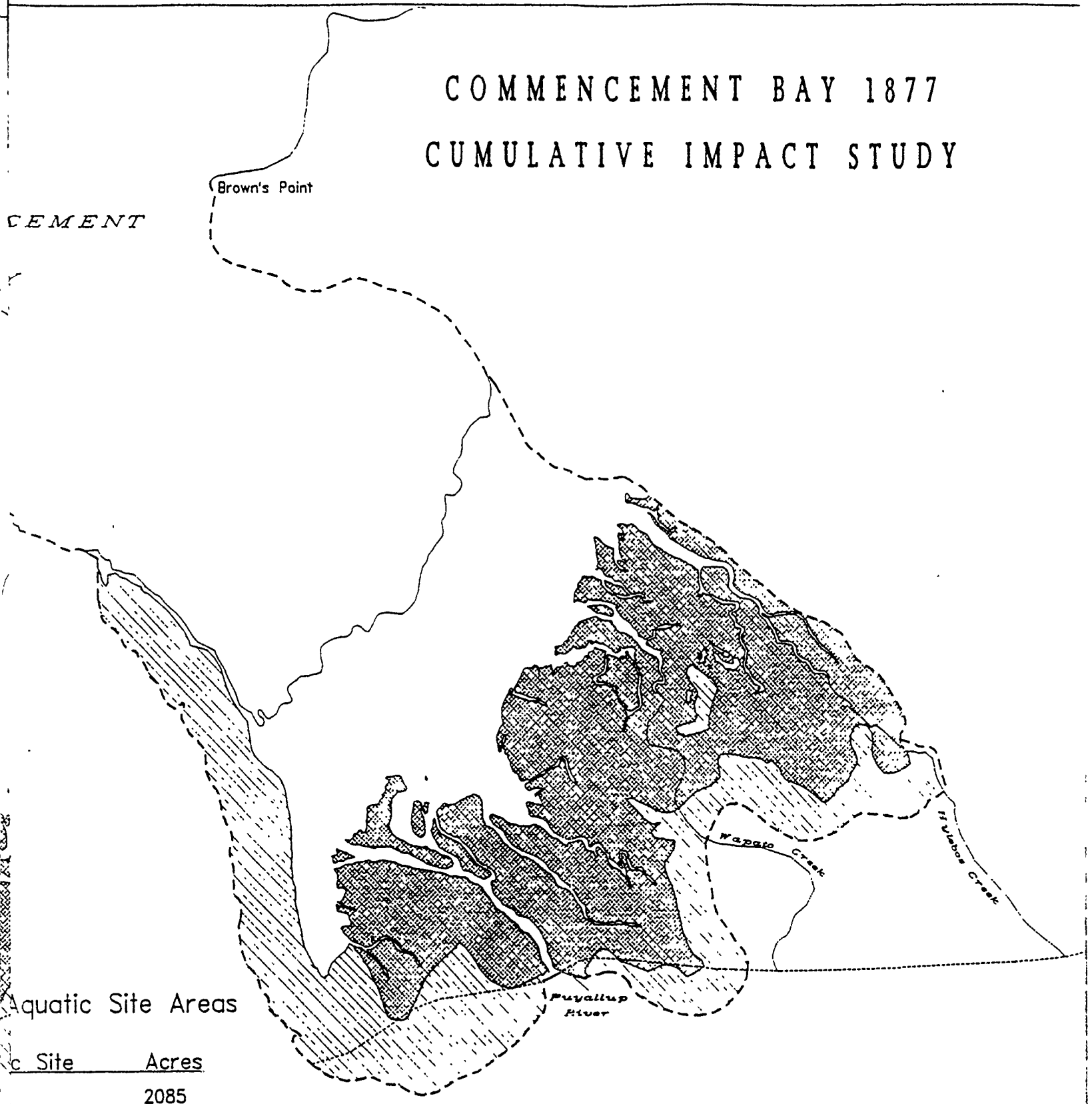
Source: Ba

COMMENCEMENT BAY 1877
CUMULATIVE IMPACT STUDY



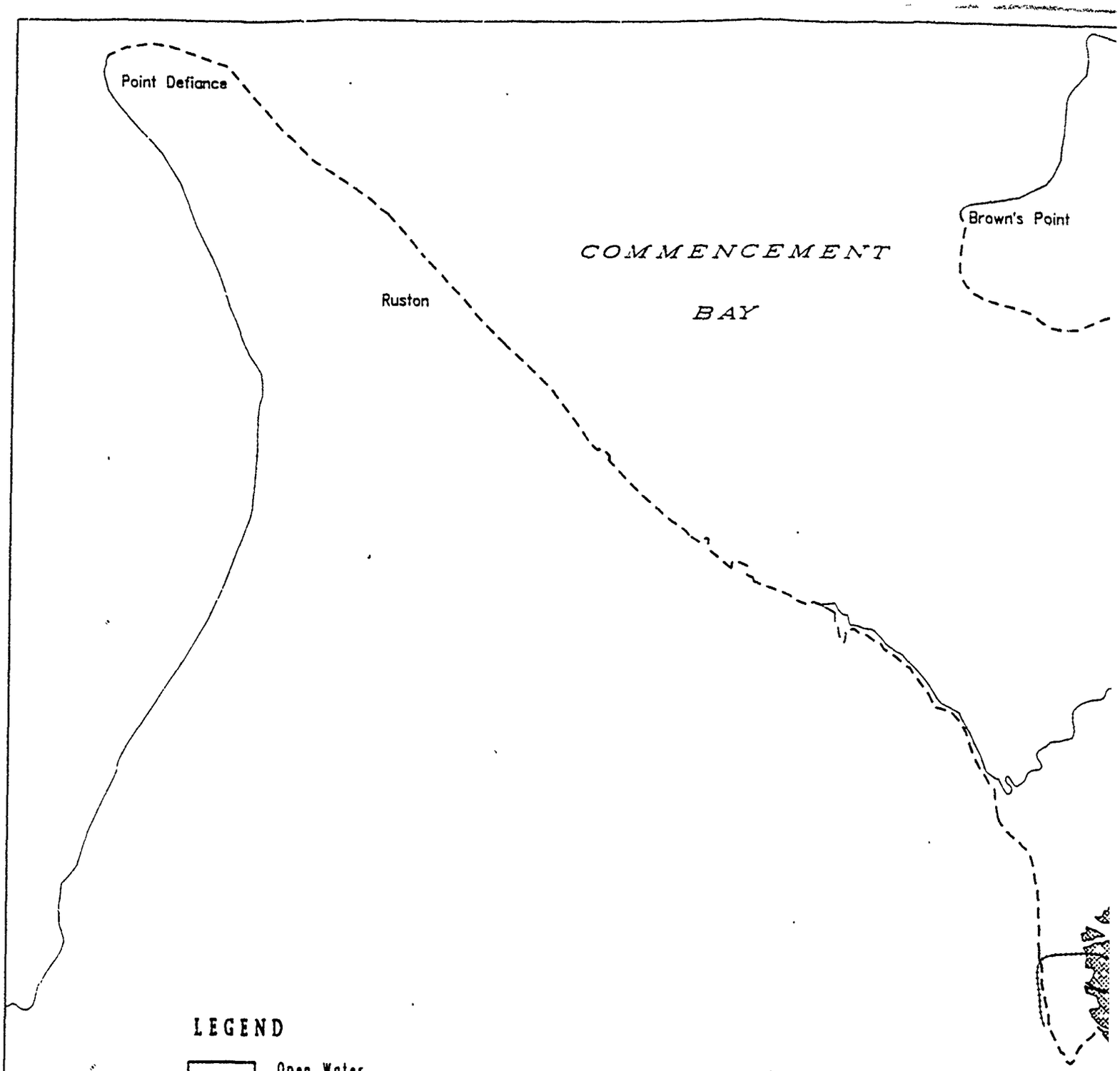
Aquatic Site Areas

c Site	Acres
	2085
nt Marsh	2539
	4624

ale 1:24000

Source: Bortelson et al 1980 (USDI Geological Survey), General Land Office 1874

Figure 2



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- Open Water
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1877 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	2085
Intertidal Emergent Marsh	3894
	5979

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COMMENCEMENT BAY 1877
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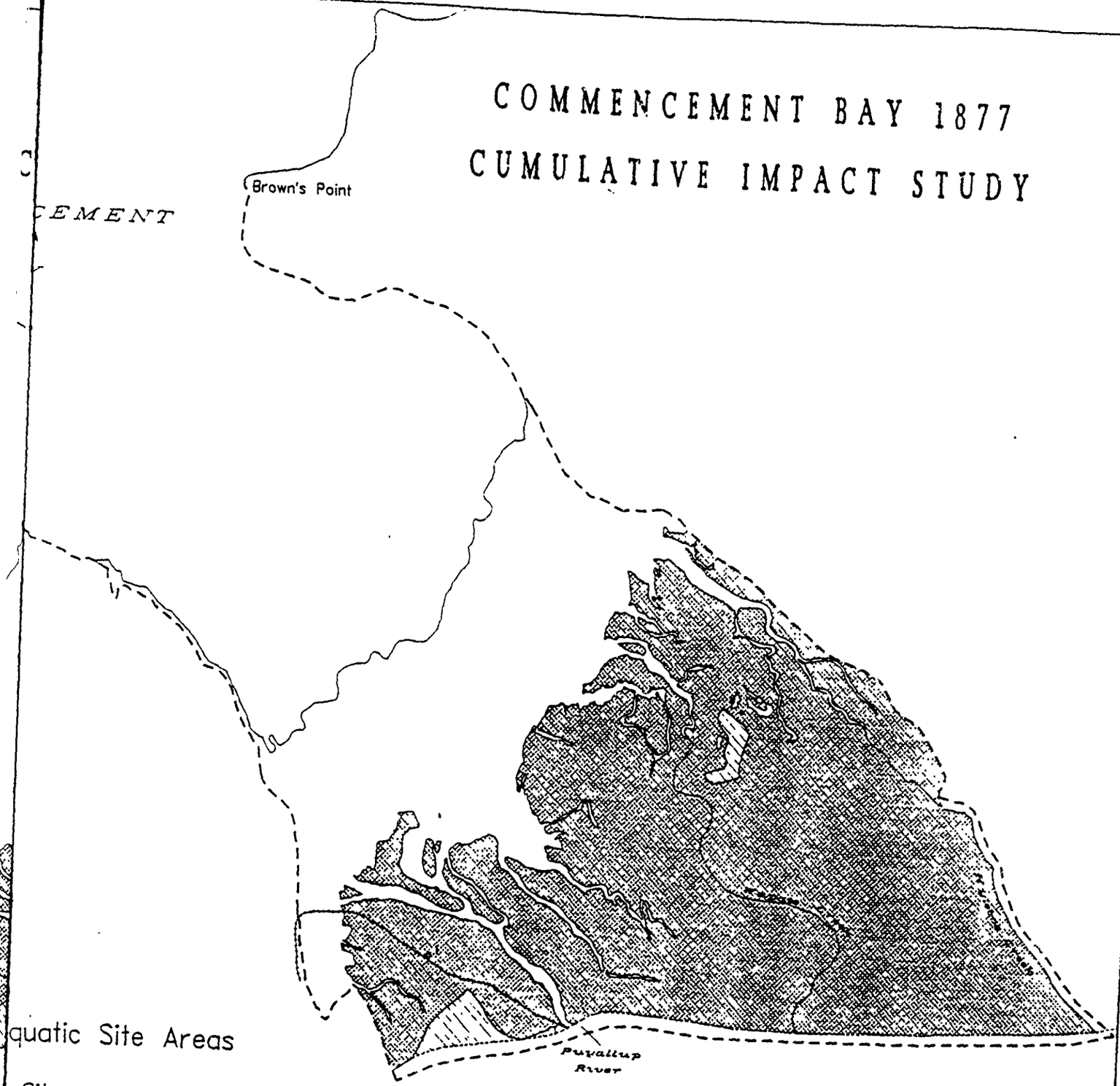


quatic Site Areas

Site	Acres
	2085
Marsh	3894
	5979

1:24000

Source: Modified Bortleson et al 1980

Figure 3

Puget silt loam dominating the Hylebos and Wapato Creek area. Small areas are underlain by Puget fine sandy loam. All three series would be classified as hydric soils according to SCS. Considering the Tacoma Tidelands as intertidal mudflats, Tidal Marsh as saltmarsh, and probably tidelands as brackish to freshwater marsh, Figure 2 indicates that prior to the 1887 maps, approximately 2,085 acres of mudflats and 2,539 acres of salt and brackish marsh existed in the Puyallup delta region in the mid-1800's. However, Bortleson's figures for these special aquatic sites are 1,839 and 2,471, respectively. The discrepancy is largely due to somewhat arbitrary delineation of the boundary between the intertidal zone and the emergent marsh zone, especially near the mouths of the dendritic channels. In addition, Bortleson's "subaerial marsh" (identified as freshwater and brackish emergent marsh) does not extend south to the area of present-day Interstate 5. His mapping terminates at the approximate line of the Tacoma muck/Puget silt loam boundary. Therefore, habitat determination in this area is somewhat conjectural. Evaluation of information gathered in the present study suggest that this area may indeed have been emergent marsh as well. The following paragraphs clarify this claim.

The Pierce County soil survey (1939) identifies a "tidal marsh" as lands with zero to one percent slopes occurring on "*low-lying wet saline marshy coastal areas traversed by winding tidal sloughs and covered by saline water during high tide. Tidal marsh supports a growth of salt-tolerant grass and plants and is of no agricultural value.*" This description indicates a typical salt marsh (see frontispiece).

According to Cooper (1860), common plants occurring in salt marshes include: Pacific silverweed (*Potentilla anserina*), Pacific water parsley (*Oenanthe sarmentosa*), slender glasswort (*Salicornia herbacea* = *S. europaea*), willow dock (*Rumex salicifolius*) and golden dock (*Rumex persicarioides* = *R. maritimus*), baltic rush (*Juncus balticus*) and toad rush (*Juncus bufonius*), softstem bulrush or tule (*Scirpus lacustris* = *S. validus*) and saltmarsh bulrush (*Scirpus maritimus*), sitka sedge (*Carex sitchensis*), hairgrass (*Aira elongata*), and California brome (*Ceratochloa grandiflora* = *Bromus carinatus*). As this latter species is not a wetland plant, it was probably misidentified or misclassified during Cooper's surveys. The major species occurring in the mudflats (and on slightly higher ground) was seaside arrowgrass (*Triglochin maritimum*). Cooper's references to general marsh species included broadleaf cattail (*Typha latifolia*) and creeping spikerush (*Eleocharis palustris*). This is in general agreement with Smith (1940) who reported that the Puyallup and Nisqually Indians living in the delta regions were using cattail (*Typha* sp.), bulrush or tule (*Scirpus* spp.) and yellow-cress (*Rorippa* sp.) for baskets and dyes.

Morgan (1991) reports tule or bulrush (*Scirpus* spp.) dominated the area from approximately the mean higher high water line up-delta to the area near Interstate 5. There a line of trees marked the boundary between brackish and freshwater marsh. However, the Bortleson map (1980) indicates that approximately 2,471 acres of the delta were "subaerial marsh" consisting of undifferentiated freshwater marsh and salt marsh. The map patterns indicating marsh do not extend fully to the present location of Interstate 5. A border of "forested upland" surrounds the subaerial marsh. This is in contrast to Morgan, Slip and Puyallup tribal sources, who suggest that the tidal marsh extended fully to the present location of Interstate 5 encompassing 3,894 acres (Figure 3, but cf. Figure 2). Because of tidal influence this area may have been primarily brackish marsh rather than solely salt marsh.

Upland vegetation information is lacking; however, upstream along the Puyallup River (in a line approximately five miles south of Interstate 5), forest vegetation evidently predominated. The species thought to occur include: Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), and hemlock (*Tsuga heterophylla*) (Port and City of Tacoma 1922). These species are often more characteristic of uplands than wetlands and therefore it is reasonable to assume that this region consisted of upland forest. The wetland/upland boundary may indeed have been near Interstate 5 (Plate 1).

3.4 Historic Periods

Changes which occurred in the area since the period described as original conditions are presented below within seven Historic Periods. The dates for each Historic Period were selected based upon the available maps and published information that could be located within the resources that were reasonably available. Six fairly accurate maps were found that visibly showed the progression of development over time. These six maps were published in the years 1877 1894, 1907, 1917, 1927, and 1941. These dates in turn established the time frame for the seven Historic Periods.

A summary of the activities occurring in each Historic Period is given in Table 8 at the end of this section. Likewise, a chronological overview of industrial development and their associated by-products is presented in Table 9 at the end of this section. These tables contain the GIS map reference numbers indicating site locations, the major events, applicant or owner (industry and by-products), and cited fill and dredge amounts. In addition, a

"running tab" on the previous condition, functional values, extent of special aquatic sites, alteration of the sites, and trends of development during the Historic Period is presented.

3.4.1 Period "I" pre-1877

These dates were chosen for the first Historic Period based on the first available maps and information regarding development activities on special aquatic sites. Information for this Historic Period is limited because very few sources were available or very explicit for Commencement Bay. According to our research the railroad was the first development to occur in the salt marsh of Commencement Bay. The Northern Pacific Railroad which traversed salt marsh from the City of Puyallup to Tacoma (site of the City Waterway) was completed in 1874. Aside from the estimated 10 acres of salt marsh and mudflat filled for the railroad construction, there is no other record of significant salt marsh filling during this period. See Table 8 for a summary of activities occurring during this period.

Table 1. Areal Extent of Special Aquatic Sites prior to 1877 (from Figure 3)

Original Habitat	Areal Extent (ac) prior to 1877	Habitat Lost (ac)	Areal Extent (ac) 1877
Intertidal mudflat	2,085	--	2,085
Salt/brackish marsh	3,894	--	3,894

3.4.2 Period "II" 1877 to 1894

The data for this Historic Period is limited because very few sources were consistent. It is evident that lumber was becoming a major industry and that large quantities of sawdust were generated and possibly used as fill for wharves or simply disposed of in the Bay (Sanborn, 1885-96). Wharves and piers first appeared on the western side of Commencement Bay along the Tacoma waterfront. The railroad became further established during this period. Piers and warehouses were built for the storage and transfer of cargo and freight between shipping vessels and trains.

Plate 1

"Tacoma About 1880"

(Photographed from the original by courtesy of
the Washington State Historical Society.)

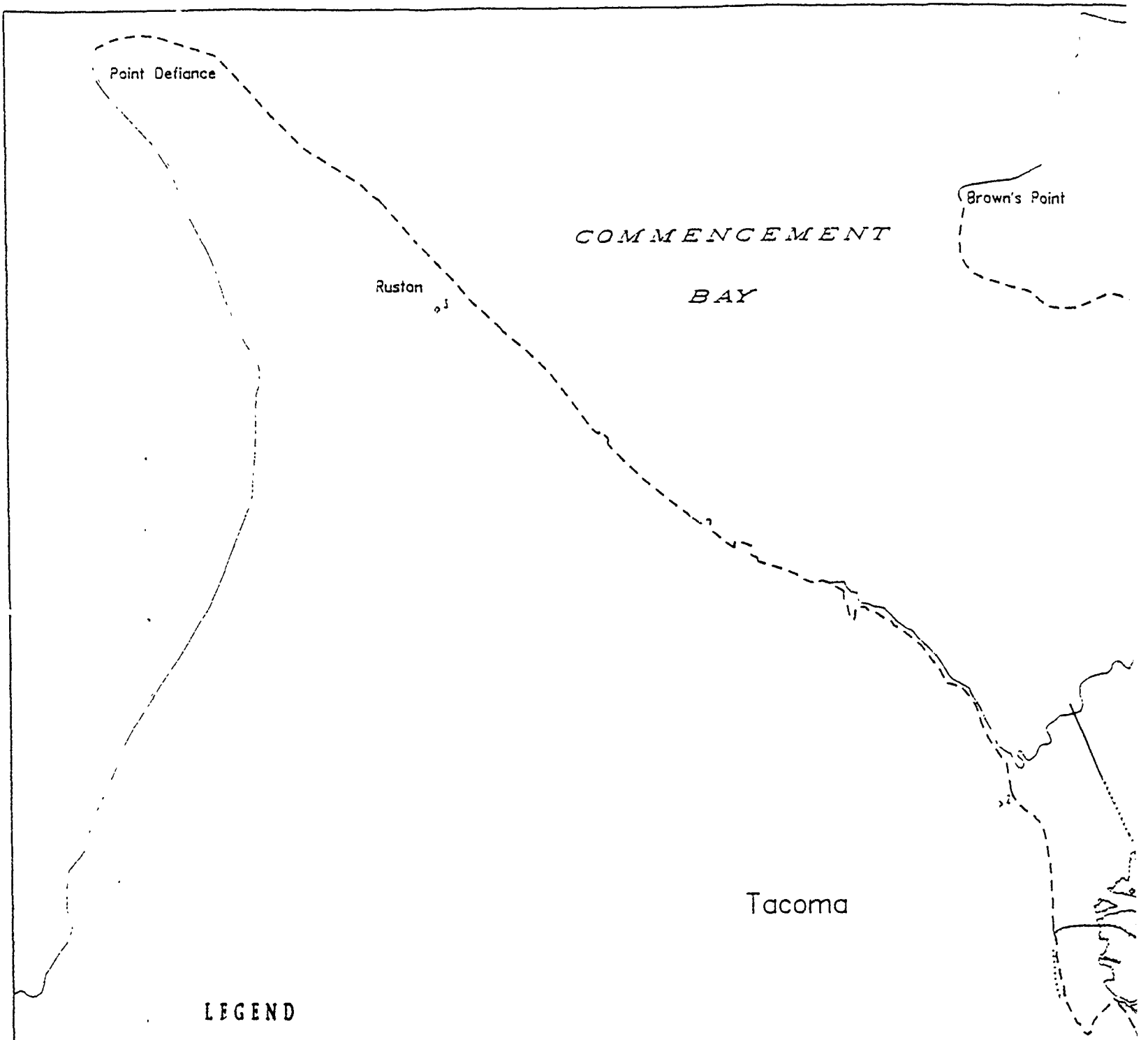
Puyallup River is evident in the upper third of the photograph, in part flanked by trees. The "tree-line" referred to in Section 3.3 is visible in the distance. The Northern Pacific Railroad shows up well, crossing the marsh and mudflats.

During this period development activities apparently were confined to pier and wharf construction along the west shore of Commencement Bay in contrast to purposeful dredging operations conducted during later periods. However, the introduction of pilings treated with tar into the tidal and intertidal areas may have had some adverse impact on the plant and animal communities in the immediate vicinity.

Figures 2 and 3 show the existing conditions in Commencement Bay in 1877 according to Bortleson (1980) (Figure 2) and proposed differences by DEA (Figure 3). Of the approximately 2,085 acres of intertidal mudflats originally present, at least one acre was effectively altered by the construction of the St. Paul and Tacoma Lumber wharf. The reduction of solar influence and lowering of temperatures under the piers resulted in an overall reduction of habitat value in the shaded areas. The wharf was about 300 feet long and was built seaward from "Boot Island" (an irregularly shaped marsh island just above mean high water line adjacent to the Puyallup River mouth). The wharf extended from the St. Paul Tacoma Mill and tied into a spur off the Northern Pacific Railroad. Although no record of the fill types and quantities used for the construction of the mill are available, it is estimated that about 10 acres of salt/brackish marsh were affected during its construction, and some areas were filled near the mill (see next Historic Period). Additionally, several log storage ponds were excavated in the mudflats adjacent to the mill, and it is estimated that about 10 acres of intertidal habitat were dredged (Table 2, Figure 4). See Table 8 and 9 for a summary of specific activities occurring during this Historic Period.

Table 2. Changes in Areal Extent of Special Aquatic Sites from 1877 to 1894.

Original Habitat	Areal Extent (ac) 1877	Habitat Lost (ac) (non-graphical sources)	Areal Extent (ac) 1894
Intertidal mudflat	2,085	(11)	2,074
Salt/brackish marsh	3,894	(20)	3,874



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Fill
- Study Area Boundary
- Future Site of I-5

N

1894 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	2074
Intertidal Emergent Marsh	3874
	5948

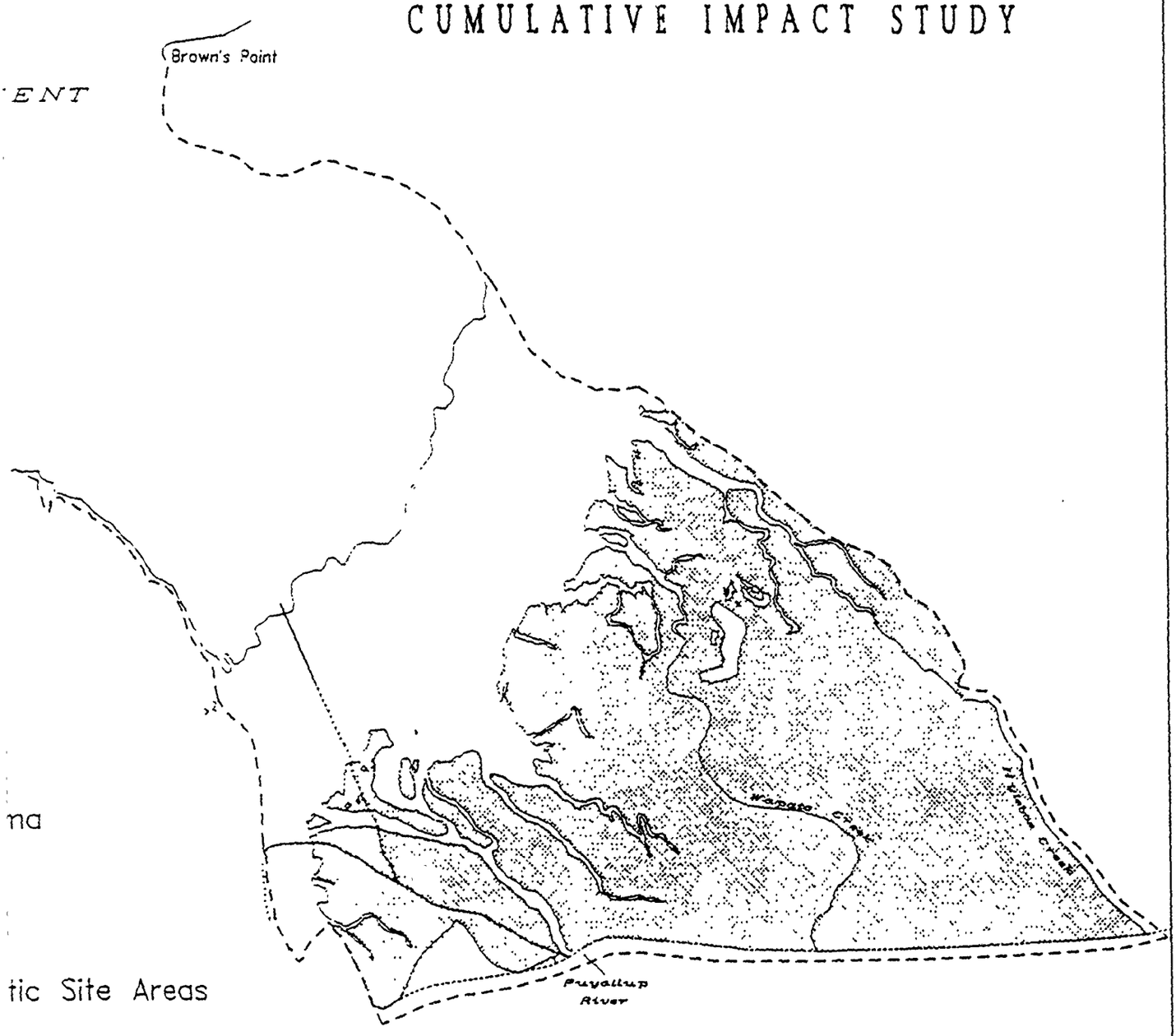
1/2 0 1 MILE

Scale 1:24000

Sources: US Ge

David Evans And Associates, Inc.
Engineers, Surveyors, Planners
Landscape Architects, Scientists

COMMENCEMENT BAY 1894
CUMULATIVE IMPACT STUDY



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tic Site Areas

e	Acres
	2074
sh	3874
	5948

4000

Source: US Geological Survey 1894 (15-minute series) General Land Office 1894

Figure 4

3.4.3 Period "III" 1894 to 1907

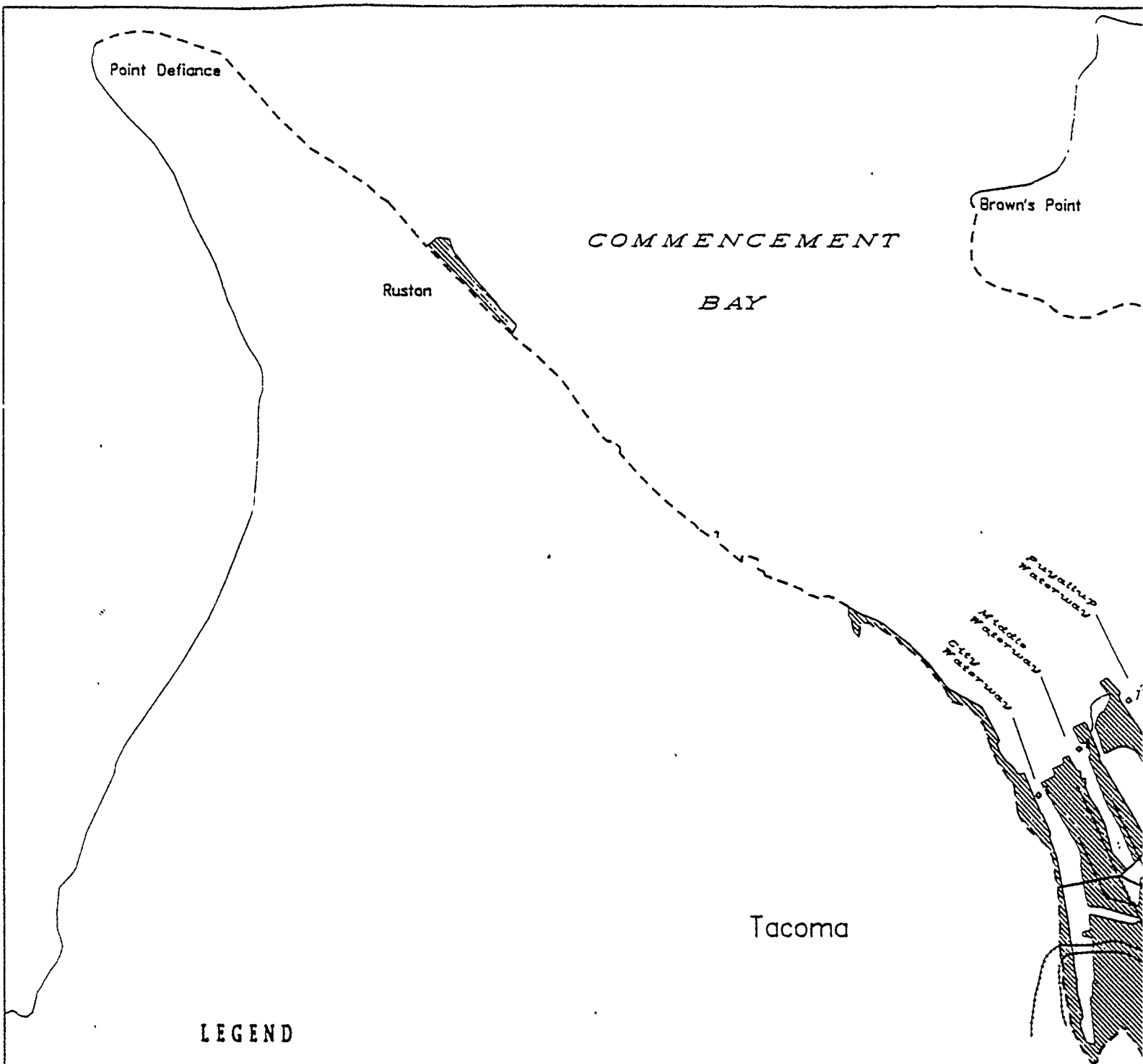
During portions of this period and the preceding one, approximately 40 acres adjacent to the mill were filled with refuse slabs to depths of 20 feet. Reports from The Tacoma Daily Ledger (1896) suggest that a one acre area below the St. Paul and Tacoma Lumber wharf was filled with refuse slabs from the mill. In 1898 the Tacoma Land Company's "seawall" was completed. This was probably a barrier to upland erosion along the west bank of the City Waterway. The material used for the seawall consisted of 85 cords of "fir boughs". In 1890, piles were driven into the waterway to support the wharf built adjacent to the seawall. No significant impact to aquatic sites resulted.

During this period, the Federal Government initiated plans to dredge several waterways on the west side of Commencement Bay (Figure 5). The first project began in 1902 in City Waterway (U.S. Board, 1925 and 1941). Approximately 3.1 million cubic yards of material were removed from 97.5 acres of intertidal area. Most of the dredged material was apparently side cast.

In 1905 dredging started on the Puyallup River to excavate the channel. The Federal Government's progress was hindered by floods in 1909 which caused excessive sedimentation of the river bed (U.S. Board, 1910 and 1925). Prior to the flooding, 1.7 million cubic yards of material were removed from 41.9 acres of mudflats and sidecast on either side of the waterway. Congress directed that no further work be done on the Puyallup River until local interests diverted the river from the waterway or devised another plan to prevent sedimentation.

Work started on the Middle Waterway during this period but the exact dates were not verified. Two different accounts and several maps corroborate that 810,000 cubic yards of material were excavated and deposited by sidecasting (U.S. Board, 1925 and 1941). This destroyed another 18.6 acres of mudflats.

During this same period a shallow basin was dredged between the Middle Waterway and Puyallup River. Approximately 50 acres of intertidal mudflat were removed and sidecast to create a log boom storage area. This waterway was not developed for navigation (U.S. Board, 1925 and 1941). Table 3 summarizes these areas for Historic Period III.



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Fill
- Study Area Boundary
- Future Site of I-5

N

1907 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	1469
Intertidal Emergent Marsh	3459
Filled Areas	870
	5798

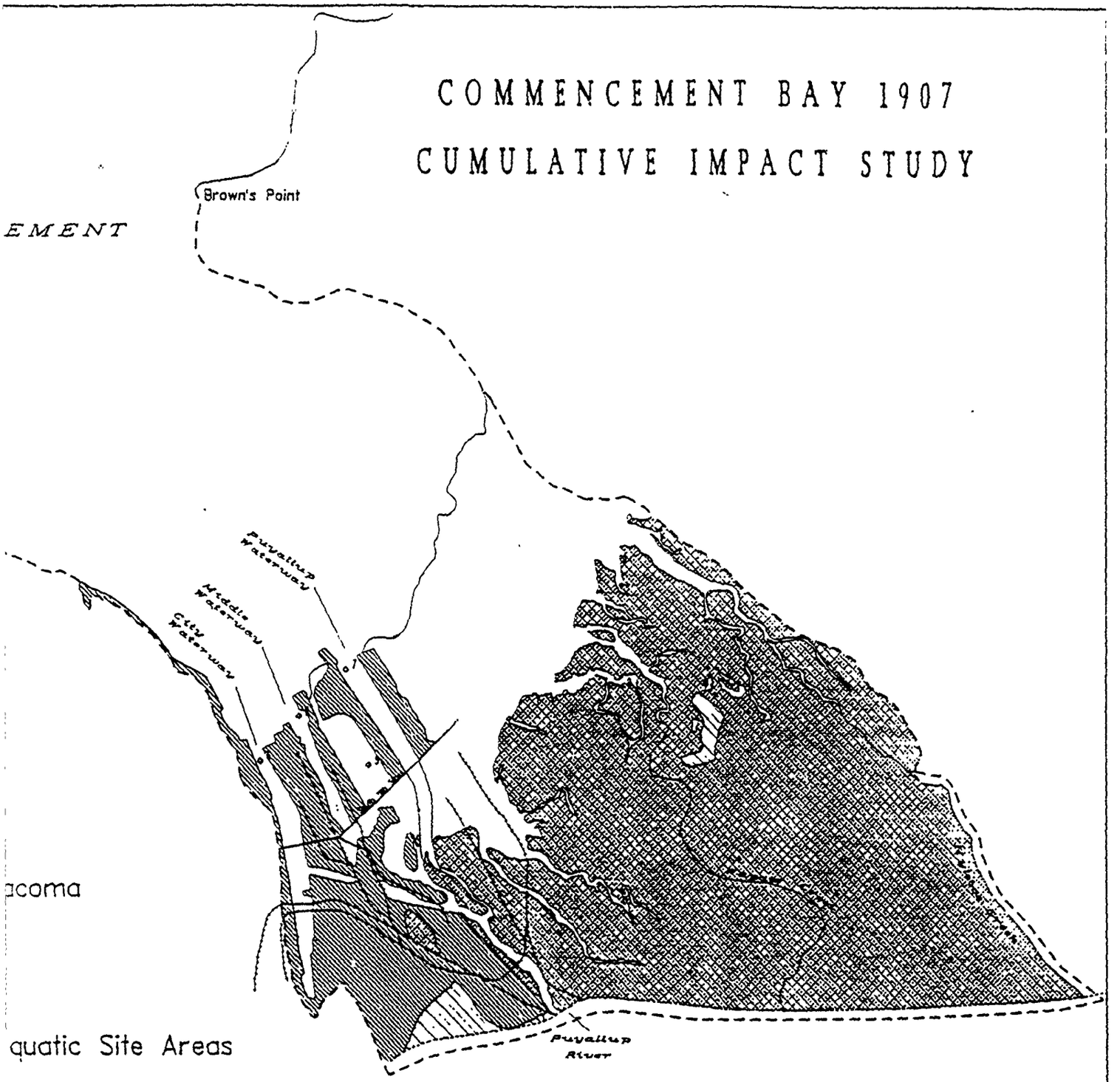
1 1/2 0 1 MILE

Scale 1:24000

Source: White

David Evans And Associates, Inc.
Engineers, Surveyors, Planners
Landscape Architects, Scientists

COMMENCEMENT BAY 1907
CUMULATIVE IMPACT STUDY



EMENT

acoma

quatic Site Areas

Site	Acres
	1469
Marsh	3459
	870
	5798

e 1:24000

Source: White 1907 (Map of City of Tacoma and Vicinity)

Figure 5

Probably the most significant alteration of habitat resulted from attempts to dredge and relocate the Puyallup River. This channel relocation probably altered the direction of flow of sedimentation resulting in filling intertidal areas, thus altering the existing pattern of mixing of the saltwater and freshwater. Any obstructions to the outflow patterns of the delta would likely reduce the salinity and increase the siltation and deposition of the area immediately behind the obstruction. As such, tidal influences to these delta areas were probably reduced and overall sedimentation increased. Additionally, loss of riverine habitat of the Puyallup River proper resulted from alteration of shape and depth of the channel.

Beginning in this period, South 11th Street was constructed in an easterly direction over a period of time. Indirect negative impacts to special aquatic sites were probably initiated during this activity and construction of subsequent roads, berms and dikes. No record of tide gates or channel diversion controls are known to have occurred during this Historic Period, however it is likely that the minimal filling necessary for the roads most likely triggered the gradual transformation from salt marsh to disturbed brackish marsh. See Table 8 and 9 for a summary of specific activities occurring during this Historic Period.

Table 3. Changes in Areal Extent of Special Aquatic Sites from 1894 to 1907.

Original Habitat	Areal Extent (ac) 1894	Habitat Lost (ac) (non-graphical sources)	Areal Extent (ac) 1907
Intertidal mudflat	2,074	(208)	1,469
Salt/brackish marsh	3,874	(41)	3,495

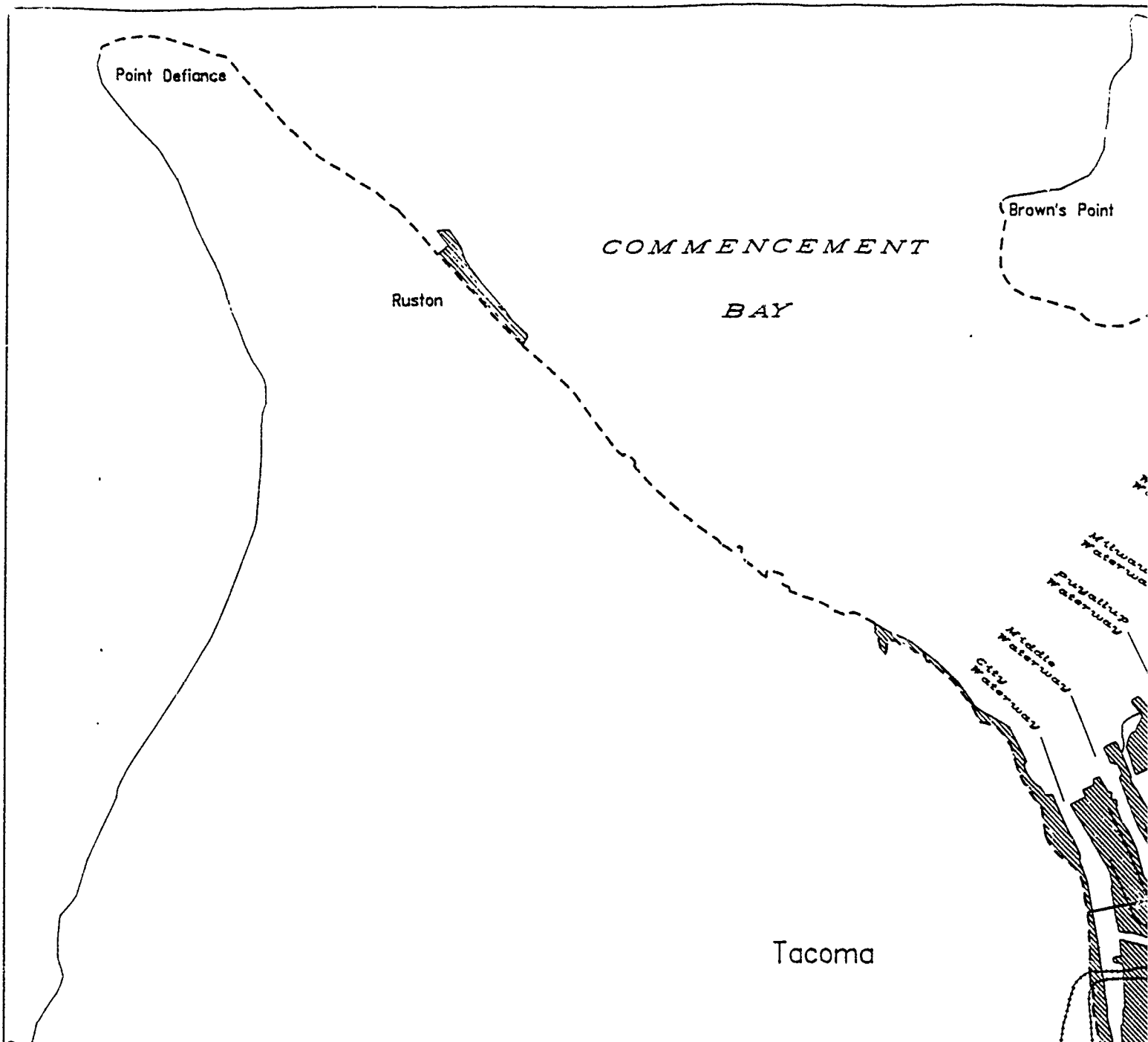
Thus, during the Historic Period 1894-1907, Figure 5 indicates a net loss of 1,020 acres of special aquatic site habitat. Of these 1,020 acres, non-graphical sources (as described in the above paragraphs), account for 208 acres of intertidal mudflat and 41 acres of brackish marsh for a total of 249 acres. To 1907, 870 acres of area had been identified by the GIS mapping and White (1907) as filled; this included the slag heap near Ruston. Some of the loss of intertidal mudflat involved the dredging of the waterways, thus reducing the total study area acreage as indicated on Figure 5.

3.4.4 Period "IV" 1907 to 1917

During this period shoreline development began to shift to the east side of Commencement Bay (Figure 6). In 1910-1913 the Port of Tacoma became involved in dredging the Milwaukee Slip. This waterway was primarily used for berthing vessels at piers belonging to the Chicago, Milwaukee and St. Paul Railway (U.S. Board, 1925 and 1941, Port 1974). About 1.5 million cubic yards of material were excavated which displaced 22.7 acres of intertidal mudflat.

A few years later the Port of Tacoma began dredging the Hylebos Waterway through which the Hylebos River enters the Bay. A navigable channel was initially created from the Bay to South 11th Street. Approximately 0.9 million cubic yards of material was unearthed corresponding to about 24.2 acres and deposited mainly on the west side of the channel, an area formerly intertidal mudflat. Eventually (exact dates not documented) the channel extended to Lincoln Avenue which displaced an additional 0.5 million cubic yards of mudflat/creek bed and widened the pre-existing Hylebos Creek. This waterway was primarily used by vessels in the lumber trade (U.S. Board, 1925 and 1941).

According to 1912 Sanborn Fire Insurance Maps several wharves and warehouses were in operation along the whole Tacoma waterfront. From south to north there was one Municipal Dock and five Commercial Docks mostly serving as grain and freight warehouses. They all were accessed by the Northern Pacific Railroad who operated numerous tracks behind the warehouses. Northern Pacific Railroad owned and operated a local freight warehouse, ocean freight warehouse, coal bunkers, and the Oriental Dock. They also constructed a wharf that extended out into Commencement Bay and covered approximately 11,500 square feet (0.3 acre). The next three businesses to the north were Tacoma Grain Company, Sperry Flour Company, and Puget Sound Flouring Mills Company which all had grain elevators and mills for producing flour. The first two companies possessed two wharves with conveyors that extended out into Commencement Bay. Next came a series of four lumber and saw mill companies all with wharves for lumber storage and loading. North End Lumber Company constructed a 3.5-acre log storage pond along the Bay. To the north in the town of Ruston is the Tacoma Smelting Company which deposited slag as fill in Commencement Bay (Sanborn, 1912).



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Fill
- Study Area Boundary
- Future Site of I-5

N

1917 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	927
Intertidal Emergent Marsh	3395
Filled Areas	1413
	5735

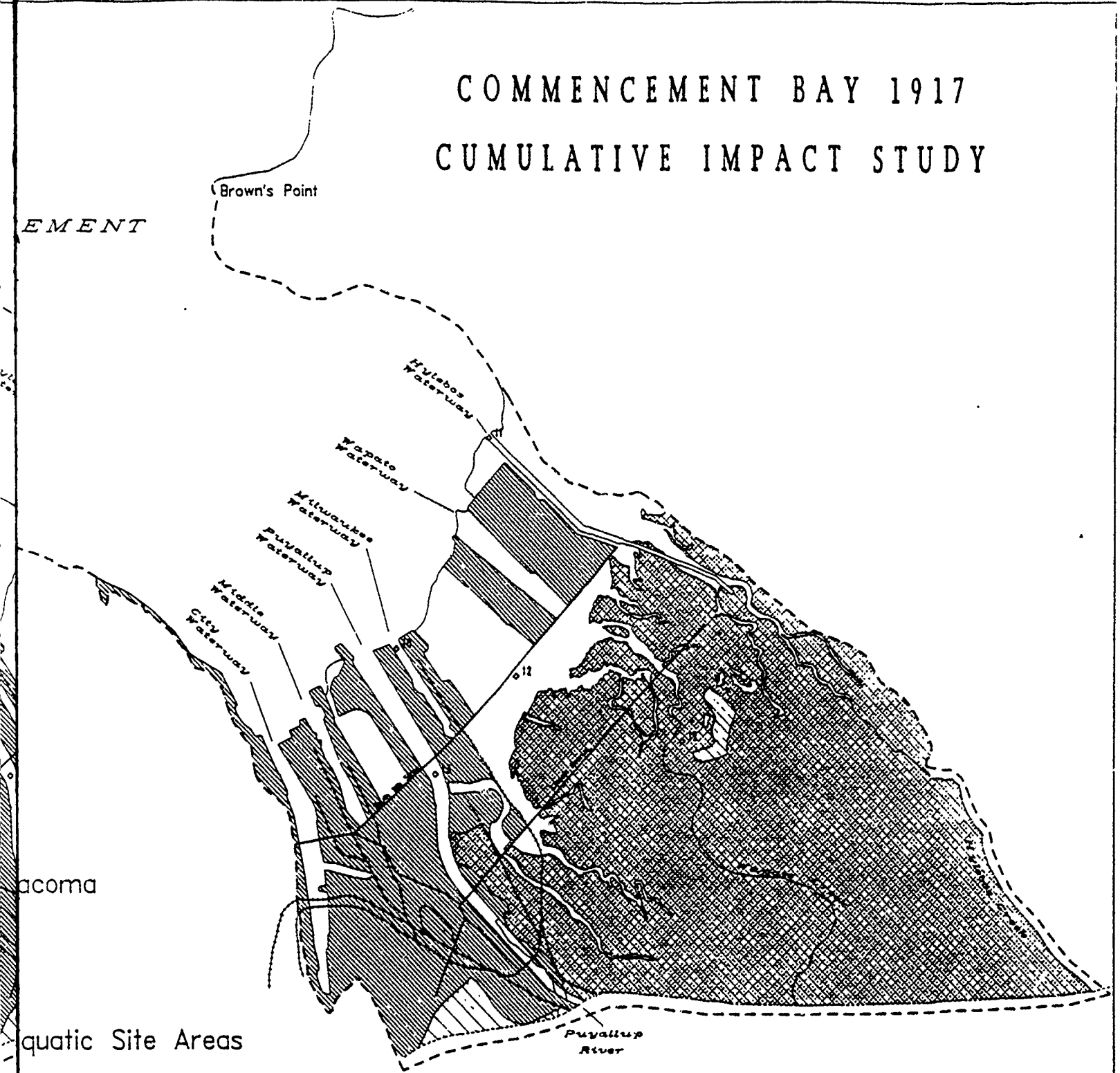
1 1/2 0 1 MILE

Scale 1:24000

Source: Br

David Evans And Associates, Inc.
Engineers, Surveyors, Planners
Landscape Architects, Scientists

COMMENCEMENT BAY 1917
CUMULATIVE IMPACT STUDY



acoma

quatic Site Areas

Site	Acres
	927
Marsh	3395
	1413
	5735

1 mile

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Source: Brown 1917 (Official Guide to Tacoma)

Figure 6

Around 1916, serious efforts were made to construct dikes to reduce tidal influence on the delta, thus "reclaiming" the salt/brackish marsh to agricultural use (Tacoma Daily Ledger, 1916). The Hylebos diking commission commenced work on a one and a half mile long dike on Lincoln Avenue. By the end of this Historic Period, a total of about 110,000 cubic yards of material had been used in the dikes. This corresponds roughly to about 7.3 acres of lost salt/brackish marsh habitat. Tide gates and associated ditches were installed in order to convert about 1,800 acres of previously "unusable land". Based on these reports it seems reasonable to assume that South 11th Street was also regularly modified and diked. Diking of other areas to reclaim lands south of South 11th Street and Lincoln Avenue brought the loss total to 27.9 acres of filled salt/brackish marsh. Table 4 presents a summary of these areas affected during this Historic Period.

These activities initiated major changes to the salt/brackish marsh habitat. As the regular saline influxes from tides diminished, areas landward probably became less saline. The rivers would continue to bring freshwater and sediments toward the dikes, resulting in an increase in sedimentation against South 11th Street. This continued to occur into the 1940's as seen on Corps aerial photographs dating from 1946. Alterations in the volumes of sediment and reduction in salinity slowly changed the overall physical and biological characteristics of the marsh from plant associations of salt marsh to brackish marsh (Tacoma Daily Ledger, 1916). This continued to occur into the 1950's.

Tide gates were probably located in culverts and served only the larger of the delta channels such as the Wapato and a drainage feature between the Puyallup River and Wapato Creek. On aerial photographs other channels appeared to be simply cut off by the road berm (Plate 2). Sections 3.4.3 and 3.4.4 discuss some of the ramifications of such activities. Lateral freshwater movement into the expansive delta was severely reduced by the installation of dikes along the Puyallup River upstream as far as "Puyallup City". These dikes eliminated the regular flooding events that occurred in the delta. Thus, freshwater movement became more confined to existing drainage courses and only surface inundation during storm events perpetuated some of the dendritic patterns normally associated with a large delta. See Table 8 and 9 for a summary of the specific activities occurring during this Historic Period.

Plate 2

"Commencement Bay, circa 1920"

(Photograph courtesy of the Port of Tacoma)

This is view looking west presumably from bluffs above Hylebos Creek. Eleventh Street appears to have been constructed on pilings and was used as a railroad track until about the early 1940's when it became a road for automobile traffic. The second drainage channel is probably a fork of Hylebos Creek. Most likely the emergent vegetation consisted of sedges (*Scirpus* spp. and *Carex* spp.).

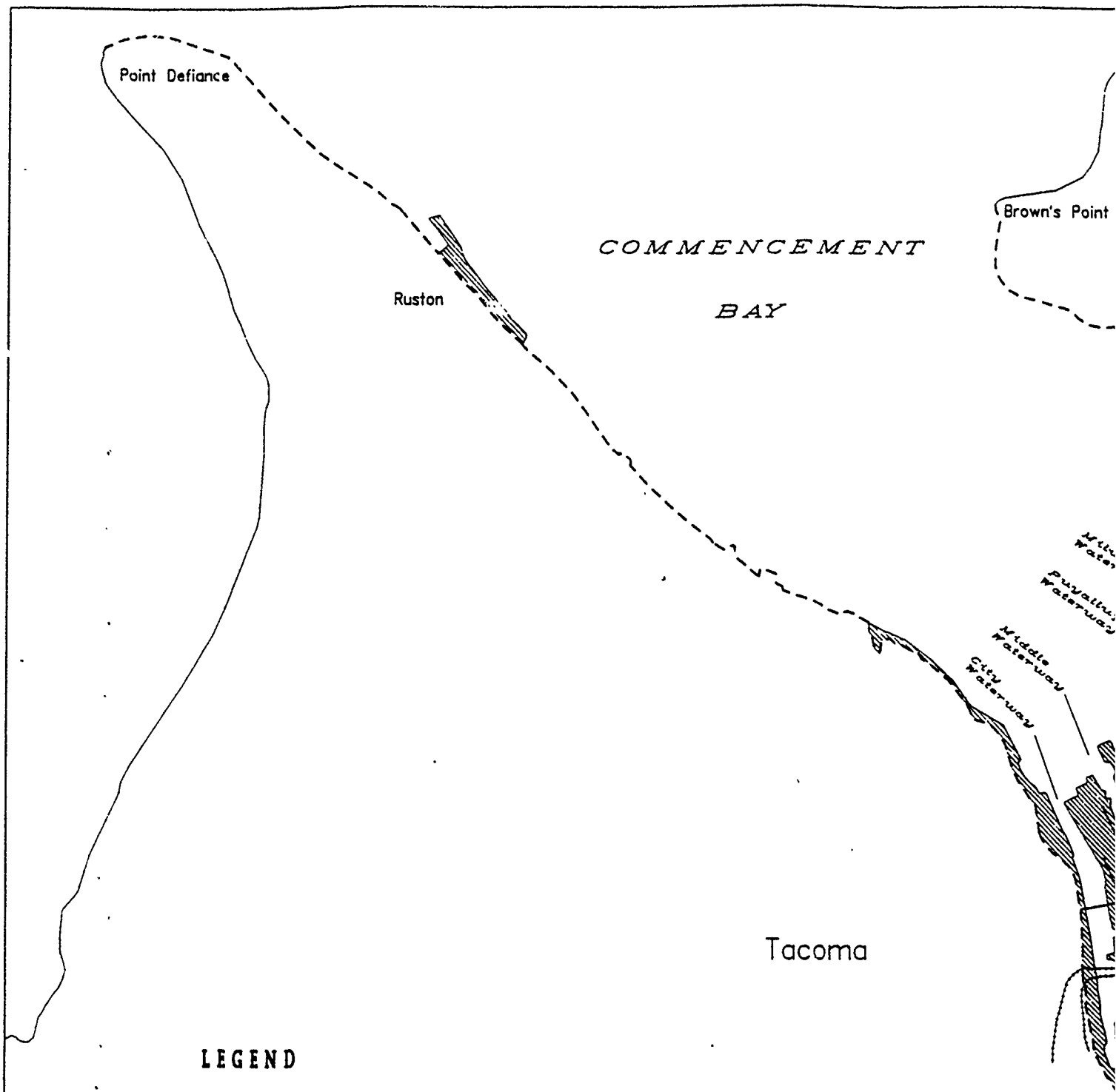
Table 4. Changes in Areal Extent of Special Aquatic Sites from 1907 to 1917.

Original Habitat	Areal Extent (ac) 1907	Habitat Lost (ac) (non-graphical sources)	Areal Extent (ac) 1917
Intertidal mudflat	1,469	(51)	927
Salt/brackish marsh	3,459	(35)	3,395

Thus, during the Historic Period 1907-1917, Figure 6 indicates a net loss of 606 acres of special aquatic site habitat. Of these 606 acres, non-graphical sources (as described in the above paragraphs), account for 51 acres of intertidal mudflat and 35 acres of brackish marsh for a total of 86 acres. The 606 acres of lost intertidal mudflat and brackish marsh is included in this 1,413 acres of fill and waterways development. To 1917, a cumulative total of 1,413 acres of area had been identified by the GIS mapping and Brown (1917) as filled.

3.4.5 Period "V" 1917 to 1927

About this time and extending into the next Historic Period, the Port of Tacoma undertook terminal developments on tideflats between the Milwaukee Slip and the former mouth of Wapato Creek (Figure 7). Initially the Wapato Waterway was dredged from the Bay to South 11th Street. This section was Federally authorized and maintained to a depth of 30 feet (U.S. Board, 1925 and 1941). This dredging activity disturbed 38.6 acres of mudflats. The new sidecastings were deposited on the surrounding area to create piers, wharves and other buildable land mass. During these years only the Wapato side was developed, while the Sitcum Waterway was untouched for many years. Sufficient filling had occurred on the Wapato side to create two piers with an intervening slip width of 256 feet. Both piers encroached on a total of 9.9 acres of mudflats and both were constructed of open pile, earth filled, and accessed from South 11th Street. An open pile wharf, 60 feet long was constructed further inside the waterway (U.S. Board, 1925). Plate 2 shows a panoramic view of the delta from the bluff above Hylebos looking west. It is difficult to discern specific landmarks, however, the general dendritic patterns and associated vegetation are visible. Table 5 presents a summary of these habitat alterations during this Historic Period.



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Fill
- Study Area Boundary
- Future Site of I-5

N

1927 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	765
Intertidal Emergent Marsh	3320
Filled Areas	1532
	5612

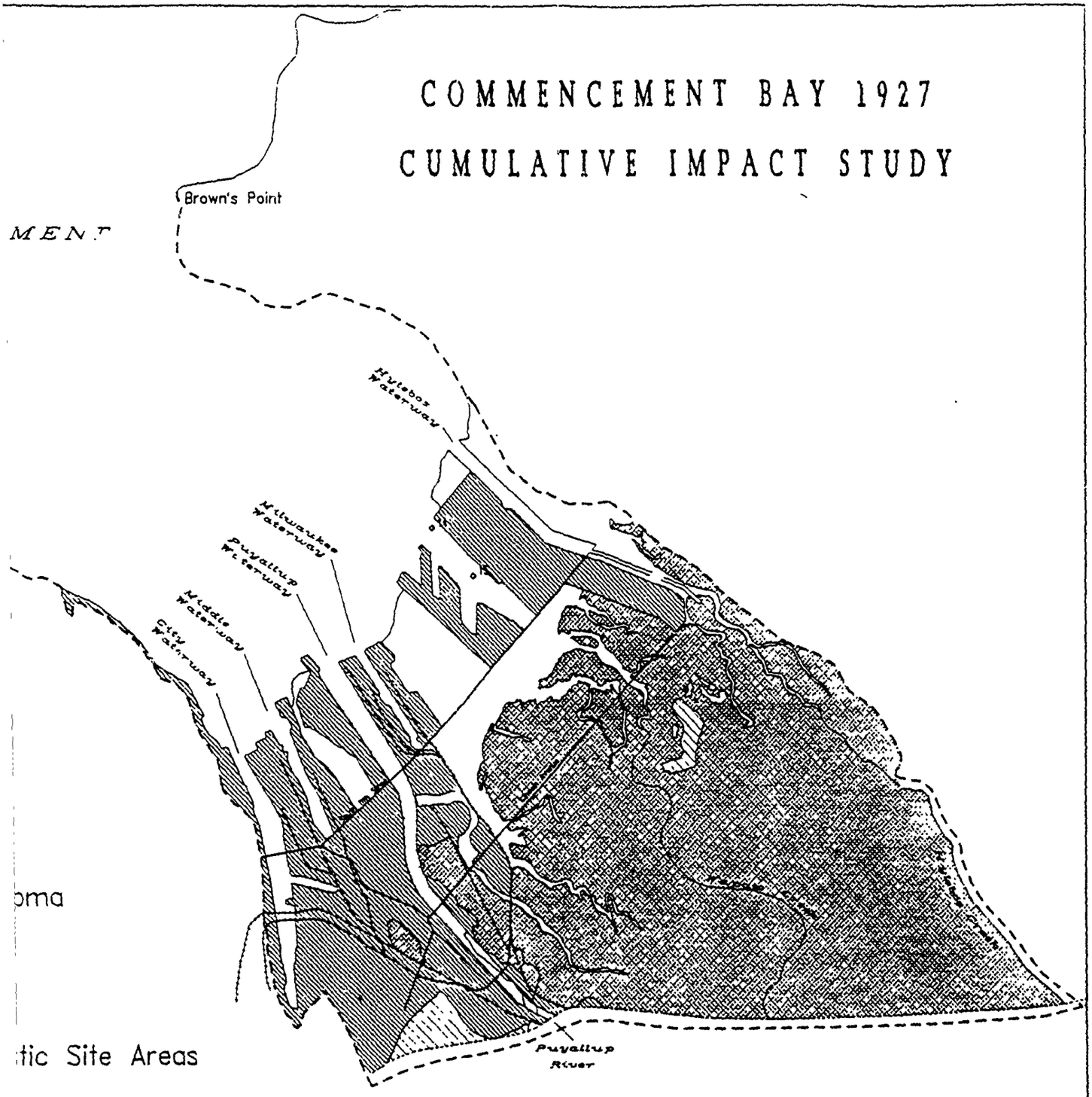
1 1/2 0 1 MILE

Scale 1:24000

Source:

David Evans And Associates, Inc.
Engineers, Surveyors, Planners
Landscape Architects, Scientists

COMMENCEMENT BAY 1927
CUMULATIVE IMPACT STUDY



MENT

oma

tic Site Areas

te	Acres
	765
arsh	3320
	1532
	5612

1 MILE

24000

Source: Meitsker 1927 (Meitsker's Pocket Map of Tacoma)

Figure 7

By the 1920's there were more of the same types of industrial activities in City Waterway and north along Commencement Bay. Freight storage and transit terminals, grain and flour mills, lumber mills, oil and coal bunkering, and shipbuilding plants and wharves were utilizing railroads and shipping for moving cargo and products. The east side of City Waterway consisted of seven wharves used for shipping and receiving hay, grain, and gypsum. The Middle Waterway was composed of three wharves: public transportation wharf on the east side operated by Oregon and Washington Railroad and Navigation Company, as well as a transit shed and cold-storage plant for fish; outfitting plant for shipping; and berthing space operated by St. Paul and Tacoma Lumber Company. On the outer end of fill between the Middle and Puyallup Waterways were two outfitting wharves at the Tacoma Shipbuilding Company. (U.S. Board, 1925).

On the west side of the Milwaukee Waterway were two pile wharves owned and operated by Chicago, Milwaukee and St. Paul Railway for foreign commerce which were equipped with tracks and transit sheds. They also owned and operated a lumber wharf on the east side of the Waterway. A grain storage warehouse was constructed at the entrance of the slip and operated by Fisher Flouring Mill Company. Another wharf on the west side of the Waterway was involved in handling the vegetable oil trade (U.S. Board, 1925).

During the 1920's the first of two piers in the Wapato Waterway was used for lumber and heavy freight. The second pier provided for freight storage and shipping facilities. At the inner end of the Waterway was a marine repair plant.

The remainder of this period was devoted to wharf construction along the Hylebos Waterway. One 1,600 foot wharf served shipbuilding interests while others ranging in length from 30 to 450 feet were used by the lumber industry (U.S. Board, 1925). Many of the wharves were constructed in areas previously dredged or those areas built up from sidecast materials, and thus, their construction did not seriously affect any special aquatic sites. See Table 8 and 9 for a summary of the specific activities occurring during this Historic Period.

Table 5. Changes in Areal Extent of Special Aquatic Sites from 1917 to 1927.

Original Habitat	Areal Extent (ac) 1917	Habitat Lost (ac) (non-graphical sources)	Areal Extent (ac) 1927
Intertidal mudflat	927	(48)	765
Salt/brackish marsh	3,395	(0)	3,320

Thus, during the Historic Period 1917-1927, Figure 7 indicates a net loss of 237 acres of special aquatic site habitat. Of this 237 acres, 48 acres of intertidal mudflat and 0 acres of brackish marsh are accountable from non-graphical sources as described in the above paragraphs. The 237 acres of lost intertidal mudflat and brackish marsh is included in these 1,532 acres of fill and waterways development. To 1927, a cumulative total of 1,532 acres of area had been identified by the GIS mapping and Metsker (1927) as filled.

3.4.6 Period "VI" 1927 to 1941

During these years the Port of Tacoma primarily extended existing waterways. Both the Hylebos and Wapato Waterways experienced additional dredging to extend, widen, and/or deepen their channels. In 1937, the Hylebos was extended from Lincoln Avenue to the upper end. About 0.8 million cubic yards of material were removed and sidecast on the west side which affected 20.2 acres of salt marsh. Simultaneously, work was being done to deepen and widen the entire channel. Some of the improvements were funded by the Federal Government (Port, 1937; Chief, 1962). This involved about 160,000 cubic yards of material with 95.8 acres of bottom mud dredged. Subsequently, the upper end of the channel was excavated to create a turning basin and connecting channel. A total of 478,000 cubic yards of material were dredged and sidecast which resulted in 9.9 acres of salt marsh burial. During Period VI, the east side remained largely undeveloped by the Port (Port, 1937; Tippetts, 1955; Chief, 1962).

The Wapato Waterway was simultaneously extended from South 11th Street through the Quadrangle, which consists of 500 acres on the tideflats between South 11th Street and Lincoln Avenue, and Sitcum and Taylor (U.S. Board, 1925; Port 1937). This project displaced 4.0 million cubic yards of material and deposited it on adjacent lands. In the process 82.5 acres of salt marsh were destroyed.

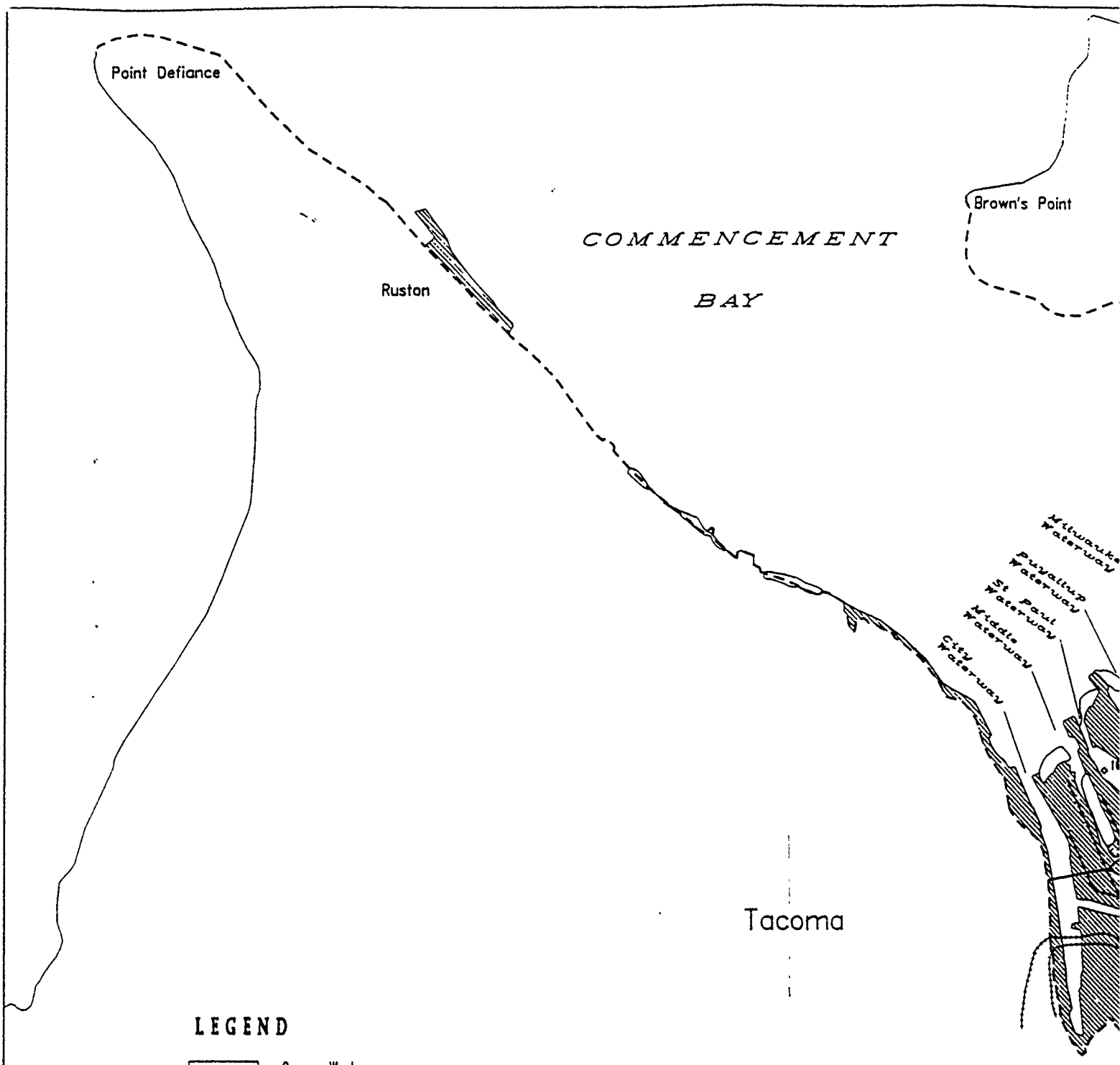
In the 1930's the St. Paul Waterway was excavated (Dames & Moore, 1981). The exact date is undocumented. Previously it had been used as a log storage pond. About 46.8 acres of mudflats were filled. This waterway is privately owned by a lumber and kraft paper company (Port, 1974).

Based on dated black and white photographs, the grain elevator was built on the bay end of the Wapato Waterway during the 1930's. The Navy shipyards were also installed during this period on the east side of Wapato Waterway (Port of Tacoma photographs, Plate 3).

In the early 1940's it is documented that City Waterway had 13 pile piers. They were utilized for lumber industry, oil bunkering, ship building, and general commerce. Middle Waterway had four wharves, three dealing with the lumber trade and the fourth for berthing vessels. Puyallup Waterway had three piers on the Bay side operating in the tug, lumber, pulp, and general commerce industries. The four pile wharves on the Milwaukee Waterway were used mainly for general cargo, as well as fish oil and grain storage. Wapato Waterway consisted of a large grain elevator and pier on the Bay side. Along the west side of the Waterway were two piers used for general cargo, a small pier for public moorage, and two wharves for marine repair and lumber. The Hylebos Waterway was composed of eight individual wharves engaged in chemicals, petroleum products, woodpulp and lumber. Three shipbuilding piers operated on the Bay side (U.S. Board, 1941).

Around 1940 about 3.1 million cubic yards of material were excavated from the Sitcum Waterway and placed in the area bound by South 11th Street, Lincoln Avenue, Milwaukee Way, and Tacoma Road. The area encompasses about 286 acres (Table 6). It is not known how much of this area was filled during this activity, but Corps photographs dating from 1946 show the area maintaining some marsh character (Plate 4). The area immediately behind South 11th Street appears to have been undergoing sedimentation. EMSL's assessment of special aquatic sites remaining resulted in the identification of what was formerly referred to as brackish or intertidal marsh as palustrine, emergent marsh, persistent (PEM1). Although impossible to accurately document, the salinity regime and habitat composition of the marshes south of South 11th Street were altered in the early to mid-1900's because of the installation of tide gates and road construction. As result, this habitat alteration occurred more gradually overtime than may appear from these Historic Periods.

Figure 8 is a composite of DEA GIS information and EMSL special aquatic site location data derived from aerial photograph interpretation. prior to 1941, information on eelgrass beds was lacking, however, analysis by EMSL revealed several locations of this special aquatic site along the western shores of Commencement Bay. See Table 8 and 9 for a summary of the specific activities occurring during this Historic Period.



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Fill
- Study Area Boundary
- Future Site of I-5

N

1941 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat	632
Intertidal Emergent Marsh	1644
Filled Areas	1869
	4145

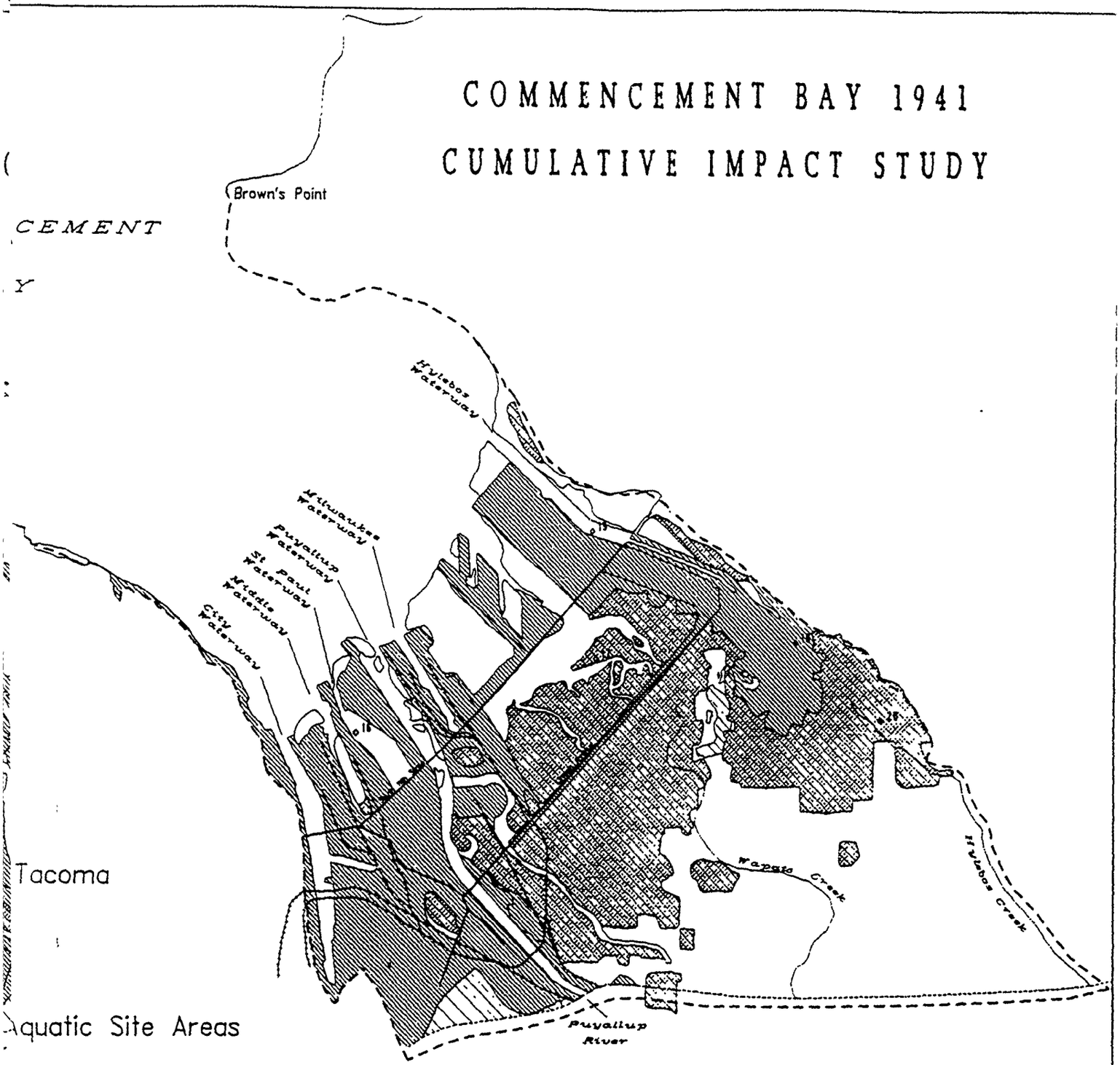
1 1/2 0 1 MILE

Scale 1:24000

Source: Whit

David Evans And Associates, Inc.
Engineers, Surveyors, Planners
Landscape Architects, Scientists

COMMENCEMENT BAY 1941
CUMULATIVE IMPACT STUDY



CEMENT

Y

Tacoma

Aquatic Site Areas

ic Site	Acres
	632
ent Marsh	1644
	1869
	4145

0 1 MILE

Scale 1:24000

Source: White 1944 (City of Tacoma), E.M.S.L. 1991

Figure 8

Plate 3

"Port of Tacoma - Aerial View From Bay to Mt. Rainier, circa 1937"

(Photograph courtesy of the National Archives)

This is a general view looking southeast, emphasizing the eastern half of Commencement Bay. Agricultural lands are visible in the background; and the degree of degradation of marsh is difficult to effectively document.


STERMAN
MFG. CO.

Plate 4

"Aerial Photograph of port of Tacoma, Corps, 1946"

(Courtesy of US Army Corps of Engineers)

Lincoln Avenue crosses the photograph from bottom left to upper right, and the effects of the tide gates under the road are obvious. This photograph was probably taken as high tide was receding. The channels in the quadrangle area are wider than those south of Lincoln due to tide gate closure. The sedimentation discussed in the text is visible here.


C 46-49

Significant additional habitat alteration occurred over time along Hylebos and Sapato Creeks. Although several photographs confirmed this gradual change from marsh habitat to agricultural lands, it is impossible to accurately identify the areal extent of these alterations. Various drainage activities coupled with dike and berm construction formed the basis of the alteration. The analysis performed by EMSL, based on high quality stereo-paired photographs, identified the extent and locations of special aquatic sites but did not differentiate between agricultural wetlands, roads, or buildings. Thus a large area north of present-day Interstate 5 was not digitized in GIS format. This area was left unclassified, however, it is likely that much of this are was agricultural, and had been in cultivation for some period of time. For the purposes of this study then, DEA left the area in Figure 7 designated as marsh and therefore Figure 8 (the composite DEA/EMSL mapping) seriously exaggerates the change in the land use over this period of time. This is clearly reflected in Tables 6 and 10.

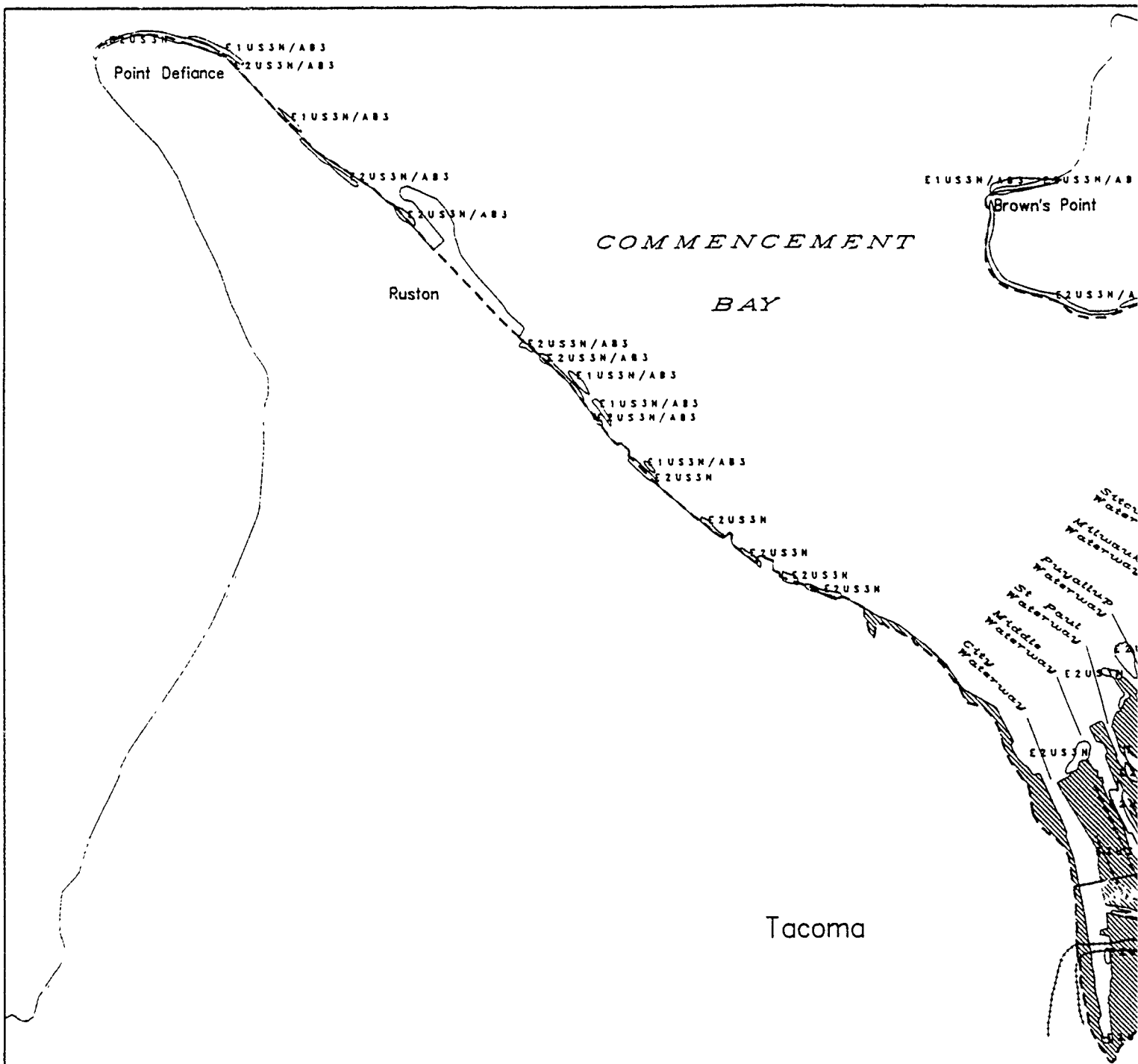
Table 6. Changes in Areal Extent of Special Aquatic Sites from 1927 to 1941.

Original Habitat	Areal Extent (ac) 1927	Habitat Lost (ac) (non-graphical sources)	Areal Extent (ac) 1941
Intertidal mudflat	765	(143)	632
Salt/brackish marsh	3,320	(399)	1,644

Thus, during the Historic Period 1927-1941, Figure 8 indicates a net loss of 1,809 acres of special aquatic site habitat. Of this 1,809 acres, non-graphical sources (as described in the above paragraphs) account for 143 acres of intertidal mudflat and 399 acres of brackish marsh. The 542 acres of lost intertidal mudflat and brackish marsh is included in this 1,809 acres of fill and waterways development. To 1941, a cumulative total of 1,869 acres of area had been identified by the GIS mapping and E.M.S.L. (1991) and White (1944) as filled.

3.4.7 Period "VII" 1941 to present

Activity during this final Historic Period saw the deepening of existing channels. Shoaling of sediments was continually a problem for navigational concerns on most of the waterways (Figure 9).



1988 Special Aquatic Site Areas

Special Aquatic Site	Acres
Intertidal Mudflat – E2US3N	187
Intertidal Mudflat/Aquatic Bed – E2US3N/AB3	73
Subtidal Mudflat/Aquatic Bed – E1US3N/AB3	17
Emergent Marsh – PEM1	57
Filled Areas	5005
	5340

N

LEGEND

- Open Water
- Forested Upland
- Fill
- Study Area Boundary
- Interstate 5

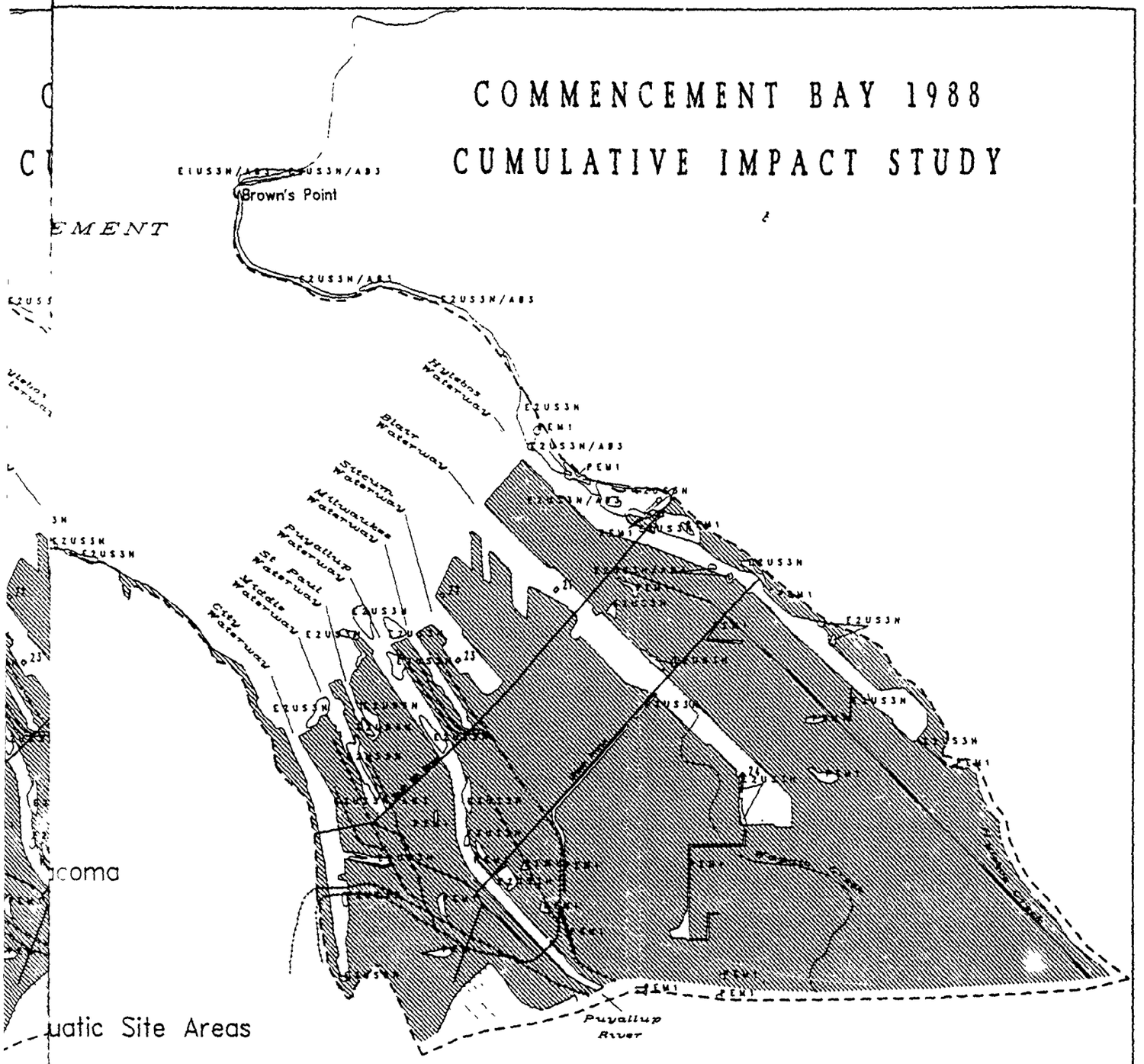
1 0 1/2 0 1 MILE

Scale 1:24000

Source:

David Evans And Associates, Inc.
Engineers, Surveyors, Planners
Landscape Architects, Scientists

COMMENCEMENT BAY 1988
CUMULATIVE IMPACT STUDY



uatic Site Areas

Site	Acres
E2US3N	187
quatic Bed – AB3	73
quatic Bed – 83	17
PEM1	57
	5005
	5340

1:24000

Source: USGS 1981 (7.5 minute series), Bottleson et al 1988 and E.M.S.L. 1991

Figure 9

In 1955 the Blair (formerly Wapato) Waterway was dredged by the Port of Tacoma from South 11th Street to Lincoln Avenue in order to deepen the channel (Tippetts, 1955). The removal of 1.8 million cubic yards of material was deposited on a tract of land south of Lincoln Avenue and west of Tacoma Road resulting in loss of about 105 acres of aquatic sites (Port, 1982) (Plate 4).

From 1957 to 1977 the east side of the Sitcum Waterway was gradually filled and two alumina storage domes were constructed. Three large buildings, probably warehouses, were also built on this filled area.

In 1979 the Sitcum Waterway was deepened by the Federal Government. No record of its actual construction was documented except by maps and photographs (Port, 1974; U.S. Army, 1979). Approximately 1.72 million cubic yards of material were removed to adjacent areas. No special aquatic sites were affected, because the areas of deposition had been previously filled.

Blair Waterway was similarly deepened during this time period by the Corps. Removal of 2.5 million cubic yards of organic silt and peat occurred. These materials were dredged and deposited on several sites south of Lincoln Avenue (U.S. Army, 1979; Port, 1982). No additional special aquatic sites were altered.

The Port of Tacoma was responsible for maintaining berthing areas in Sitcum and Blair Waterways (Port, 1974; U.S. Army, 1979). From 1972 to the present, the Port was issued six permits for this purpose, allowing almost 200,000 cubic yards of material to be removed from the waterways.

In the Corps aerial photograph dated 1946 (Plate 4) the difference in the vegetation north and south of Lincoln Avenue shows combined effects of arresting the tidal influence into areas south of Lincoln Avenue and the resultant slow siltation and "self-filling" just south of South 11th Street. Compare this photograph with documentation by the Port of Tacoma (Figure 7) that shows this area as receiving 3.1 million cubic yards of fill in 1940. From upstream sources, freshwater and sediments still moved into this area between South 11th Street and Lincoln Avenue through the drainages with tide gates, however, the movement of sediments to the sea is significantly decreased by the South 11th Street berm. The photograph also shows that sediments moving with the tides, became trapped behind the

same road berm during recession of the tides. Effectively this area was "self-filled" slowly by the entrapment of materials and salinity probably was temporarily increased in this area.

Plate 5 probably dates from the late 1940's/early 1950's. The area between South 11th Street and Lincoln Avenue appears to have been filled and linear tracks indicate some agricultural practices are taking place. Most likely the area was intentionally filled, but it is possible that some of that fill appears to be ocean derived as described above. Thus, habitat alteration in this specific area may have followed this course: 1) decreased salinity of the marsh caused by reduced number of outflow channels, 2) increased siltation as a result of the road berm "barrier", which effectively isolated the area and probably raised its topographic position by a few feet, and 3) intentional filling of the area with dredged materials from waterway development and maintenance. See Table 8 and 9 for a summary of the specific activities occurring during this Historic Period.

Table 7. Changes in Areal Extent of Special Aquatic Sites from 1941 to present.

Original Habitat	Areal Extent (ac) 1941	Habitat Lost (ac) (non-graphical sources)	Areal Extent (ac) Present
Intertidal mudflat	632	(105)	187
Freshwater marsh	1,644	(1,557)	57

Thus, from 1941 to the present, Figure 9 indicates a total loss of 1,999 acres of special aquatic site habitats. Of these 1,999 acres, 1,662 acres are accountable through non-graphical sources as described in the above paragraphs. These 1,662 acres are included in the 1,999 acres of fill and waterways development (calculated from GIS). To the present, a cumulative total of 5,005 acres of area had been identified by the GIS mapping of DEA and E.M.S.L. (1991) as filled. EMSL also identified 91 acres of intertidal and subtidal mudflat with aquatic beds, commonly known as eelgrass beds.

Plate 5

"Aerial View Looking North: Port of Tacoma, circa 1950"

(Photograph courtesy of Port of Tacoma)

The dredging of Wapato Waterway from South 11th Street south to Lincoln Avenue is in progress in this photograph. The hydraulic dredge itself is visible at the southern terminus of Wapato Waterway and is depositing the materials on an area to the east.

Areas south of Lincoln Avenue retain marsh character, but due to the tide gates installed under that road, gradually lose the tidal influx salinity and become less brackish over time.

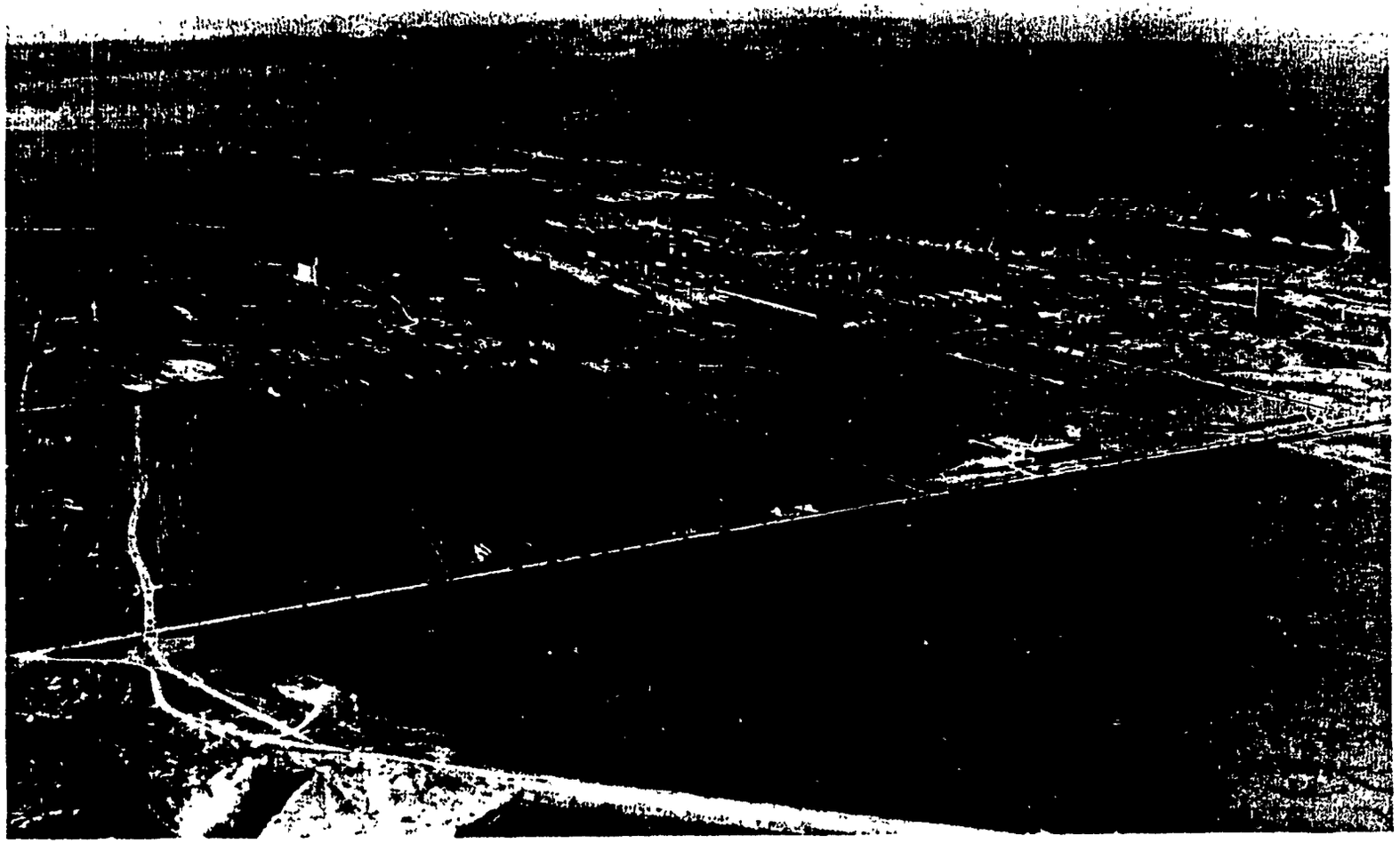


Table 8

Chronology of Commencement Bay Waterway Development

Map Refer. #	Date	Location	Event	Owner/Applic	Fill	Dredge	Areal Ext.	Special aquatic Sites and Impacts
Period I (pre-1877)								
1 - Morgan 1984	1874	crossing delta	Northern Pacific Railroad berm	Northern Pacific Railroad	unknown		Estimated 25,000′ x 40′	salt marsh (est. 10 acres)
Period II (1877-1894)								
2 - Sanborn 1885-96	1888	E. of Pac. Ave	Plank wharf- Saw & Planing	W.F. Hatch & Co.	Sawdust refuse & C.	———	No data	mudflats
3 - Sanborn 1885-96	1888	Old Town, near Rushton	Tacoma Mill Co.	Hanson & Co	Sawdust in Bay	———	No data	mudflats
4 - Morgan 1982	1888	"Boot" Island, near mouth of Puyallup River	St. Paul Tacoma mill	St. Paul Tacoma Mill	refuse slabs		Estimated 2 -3 acres	salt marsh (est. 2 - 3 acres)
5 - Tacoma Daily 1896	1888 - 1896	"Boot" Island	St. Paul Tacoma mill	St. Paul Tacoma Mill	refuse slabs		Estimated 40 acres	salt marsh (est. 40 acres)
Period III (1894-1907)								
6 - Board 1941, U.S. Board 1925	1902-1905	City Waterway	dredging of waterway	Federal Govt		Channel excavated	8500′ long x 500′ w x 20′ deep	mudflats (97.5 acres)
7 - U.S.Board 1925, U.S.Board 1910	1905-1909	Puyallup Waterway	dredging of waterway	Federal Govt		Channel excavated	3650′ long x 500′ w x 25′ deep	mudflats (41.0 acres)
8 - Board 1941, U.S. Board 1925	1907-1913	Middle Waterway	dredging of waterway			Channel excavated	3600′ long x 225′ w x 27′ deep	mudflats (18.6 acres)
9 - Board 1941, U.S. Board 1925	prior to 1907	Between Middle + Puyallup WW	dredging shallow basin			Create log boom	3900′ long x 225-900′ wide	mudflats (50.0 acres)

Table 8

Chronology of Commencement Bay Waterway Development (continued)

Map Refer. #	Date	Location	Event	Owner/Applic	Fill	Dredge	Areal Ext.	Special aquatic Sites and Impacts
Period IV (1907-1917)								
10 - Port 1974, Board 1941	1910-1913	Milwaukee Slip	dredging of waterway	Port of Tacoma		Channel excavated	3300'long x 300'w x 40-45'deep	mudflat (22.7 acres)
11 - Board 1941, U.S. Board 1925, Port 1937	1916-1917	Hylebos Waterway	dredging of waterway - Bay to 11th St. @ 11th to Lincoln	Port of Tacoma		Channel excavated	5280'l x 200'w + 3700'l x 150'w x 25'deep	mudflat (24.2 acres)
12 - Tacoma Daily	1916-1917	11th Street Lincoln Avenue	construction of dikes	Hylebos Creek District	110,000 cy	———	18,400'l x 66'w	salt marsh (est. 16.9 acres)
13 - Dames 1981	1914	Puyallup River	dredging river		Concrete levee from Bay to Puyallup City	channel excavated	est. 15,840'long (in study area)	mudflat (est. 2.4 acres) salt marsh (est. 4.8 acres)
Period V (1917-1927)								
14 - Board 1941, U.S. Board 1925	1917-1922	Wapato Waterway	dredging of waterway	Port of Tacoma		Channel excavated to S. 11th. St.	4200'long x 400'w x 30'deep	
15 - U.S. Board 1925, P	1917-1922	Wapato Waterway	Filling to create piers	Port of Tacoma	2 piers filled, 1)open pile, earth fill, 800'x160' 2)open pile, earth fill, 1200'x250' + open pile wharf 60'long	2 slips excavated, 1100'l x 300'w		mudflat 1) 3.0 acres 2) 6.9 acres

Table 8

Chronology of Commencement Bay Waterway Development (continued)

Map Refer. #	Date	Location	Event	Owner/Applic	Fill	Dredge	Areal Ext.	Special aquatic Sites and Impacts
Period VI (1927-1941)								
16 - Dames 1981	1930's	St. Paul Waterway	dredging of waterway			Channel excavated	3400'long x 600'w	mudflat (46.8 acres)
17 - Board 1941, Port 1937	1937	Wapato Waterway	dredging of waterway	Port of Tacoma		Waterway extended from the Bay to S. 11th St. and through the Quadrangle area *	4200'l x 400'w x 30' + 3200'l x 600'w x 30'd	mudflat (38.6 acres) salt marsh (44.0 acres)
18 - Chief 1962, Port 1937	1937	Hylebos Waterway	Extending channel	Port of Tacoma		Dredging from Lincoln to upper end	5880'l x 150'w x 25'deep	salt marsh (20.2 acres)
19 - Chief 1962, Port 1937	1937	Hylebos Waterway	Deepen and widen channel	Port of Tacoma		Improving channel from Bay to Lincoln and to upper end	5280'l x 400'w x 5' + 6864'l x 300'w x 5'd	mudflat (48.5 acres) salt marsh (47.3 acres)
20 - Chief 1962, Tippetts 1955, Port 1937	1937	Head of Hylebos WW	create turning basin	Port of Tacoma		excavate basin + connecting channel	900'l x 410'w x 30 + 150'l x 410'w x 30'	salt marsh (9.9 acres)

Table 8

Chronology of Commencement Bay Waterway Development (continued)

Map Refer. #	Date	Location	Event	Owner/Applic	Fill	Dredge	Areal Ext.	Special aquatic Sites and Impacts
Period VII (1941-Present)								
21 - Tippetts 1955	1955	Blair Waterway (Wapato)	Deepening waterway	Port of Tacoma		1.8 million cy	3400'l x 500'w x 10'	none - existing waterway
22 - P	1957	Sitcum Waterway	Addition to pier	Port of Tacoma	12 acre fill on north end of Sitcum behind bulkheads		12 acres	none - existing waterway
23 - U.S. Army 1979	1979	Sitcum Waterway	Deepening waterway	Federal Government			3000'l x 300'w x 40' + 1000'l x 300'w x 35'	none - existing waterway
24 - U.S. Army 1979	1979	Blair Waterway (Wapato)	Deepening waterway	Federal Government		2.5 million cy of organic silt and peat	4000' x 520' x45', 460' x 300' x45', 3200' x 520' x45', 3800' x 260' x45', 1800' x 1200' x 45'	none - existing waterway

R = references
P = photographs

* Quadrangle area is comprised of 500 acres between S. 11th St and Lincoln, and Sitcum and Taylor.

Table 9

Industry and Associated By-Products

Reference	Date	Location	Industry	Owner	By-product	Quantity
Tacoma Planning Department 1981	1888	near Ruston	Open pile wharf with tracks	Tacoma Smelting Co.	slag	Not given
Sanborn 1912	1907-1912	S. of Ruston	5 open pile wharves with movable cranes.	Danaher Lumber (2), Puget Sound Lumber, Defiance Lumber, North End Lumber	wood, sawdust	Not given
Sanborn 1912	1907-1912	City waterfront	8 commercial wharves	N. Pacific Railway	Commerce exchange	Not given
Sanborn 1912	1907-1912	City waterfront	Grain wharf	Puget Sound Flouring Mill Co., Sperry Flour Co., Tacoma Grain Co.	flour	Not given
U.S. Board 1925, Sanborn 1912	1907-1912	City waterfront at foot of N.4th.St.	Coal bunkering, local and ocean freight warehouses	N.Pacific Railway	coal storage	Not given
U.S. Board 1925	1917-1925	City Waterway, E.side,opp.S. 14th St.	Oil Bunkering	Standard Oil Co.	fuel oil storage	54,500 barrels
U.S. Board 1925	1917-1925	City Waterway, S.side,Dock St.	coal bunkering	Pacific Coast Coal Co	coal storage	Not given
U.S. Board 1925	1917-1925	City waterfront	Public transport.	Unknown	10 wharves	Not given
U.S. Board 1925	1917-1925	City waterfront	Fish wharf	N. Pacific Railway	Fish	Not given
U.S. Board 1925	1917-1925	City Waterway	Hay and grain wharf	John B. Stevens & Co.	Hay and flour	Not given
U.S. Board 1925	1917-1925	City Waterway	Gypsum wharf	Pacific Coast Gypsum Co.	Receipt of Alaskan gypsum and export of same	Not given

Table 9

Industry and Associated By-Products (continued)

Reference	Date	Location	Industry	Owner	By-product	Quantity
U.S Board 1925	1917-1925	Middle Waterway - east side	Public transportation	Oregon-Washington Railroad & Navigation Co.	Railroad wharf - 765'l x 55'w	Not given
U.S. Board 1925	1917-1925	Middle Waterway	Outfitting plant	Seaborn Shipbuilding Co.	Ships	Not given
U.S. Board 1925	1917-1925	Middle Waterway	Berthing wharf	St. Paul & Tacoma Lumber Co.	Ship berthing	Not given
U.S. Board 1925	1917-1925	Between Middle and Puyallup Waterways	Two outfitting wharves	Tacoma Shipbuilding Co.	Ships	Not given
U.S. Board 1925	1917-1925	Milwaukee Waterway - west side	Oriental business port	Chicago, Milwaukee & St. Paul Railway	Two pile wharves - 1000'l and 1020'l	Not given
U.S. Board 1925	1917-1925	Milwaukee Waterway - east side	Lumber	Chicago, Milwaukee & St. Paul Railway	Lumber wharf - 200'l x 70'w	Not given
U.S. Board 1925	1917-1925	Milwaukee Waterway - entrance to slip	Grain storage warehouse - 500' x 160'	Fisher Flouring Mill Co.	Flour	800,000 bushels storage capacity
U.S. Board 1925	1917-1925	Milwaukee Waterway - west side	Vegetable oil trade	Gillespie Oil Co. and Philippine Vegetable Oil Co.	Vegetable oil storage - one wharf 200'l	2.2 million gallons storage capacity
U.S. Board 1925	1917-1925	Wapato Waterway - entrance	Lumber and heavy freight - one pier 800' x 166' with tracks	Unknown	Lumber trade and heavy freight shipping	Not given

Table 9

Industry and Associated By-Products (continued)

Reference	Date	Location	Industry	Owner	By-product	Quantity
U.S. Board 1925	1917-1925	Wapato Waterway	Freight storage and shipping - one pier 1200' x 250'	Unknown	General freight shipping	Not given
U.S. Board 1925	1917-1925	Wapato Waterway - inner end	Marine repair plant	Western Boat Building Co.	Repair boats at open pile wharf 60'long	Not given
U.S. Board 1925	1917-1925	Hylebos Waterway - entrance	Outfitting wharf - 1600'long	Todd Dry Dock & Construction Corp.	Ships	Not given
U.S. Board 1925	1917-1925	Hylebos Waterway	Lumber mills - with several wharves 30'-450' long	Unknown	Lumber and sawdust	Not given
P, Board 1941	1930's	Wapato Waterway	Grain elevator	Port of Tacoma	Flour	650,000 bushel capacity
P	1930's	Wapato Waterway	U.S Navy	Federal government	Ship storage and repair	Not given
Board 1941	1930's	City Waterway - east side	Lumber wharf	Wheeler Osgood Co.	Lumber and sawdust	Not given
Board 1941	1930's	City Waterway - east side	Oil bunkering and handling wharves - four	Standard Oil Co, Union Oil Co, General Petroleum Corp, and Tide Water Associated Oil Co of California	Oil storage and handling	Not given
Board 1941	1930's	City Waterway - east side	Shipbuilding and repair work wharves - three	Not given	Ships	Not given

Table 9

Industry and Associated By-Products (continued)

Reference	Date	Location	Industry	Owner	By-product	Quantity
Board 1941	1930's	City Waterway - east side	Miscellaneous - four wharves	Not given	Handling contractors' supplies, hogged fuel, and marble and stone + city fireboat	Not given
Board 1941	1930's	Middle Waterway	Union Pacific Dock	H.G. Wilcox Co.	Freight handling	Not given
Board 1941	1930's	Middle Waterway	Lumber - three wharves - 200'l, 1640'l, and 400'l	Mountain Lumber Co, St. Paul & Tacoma Lumber Co, and Foss Launch & Tugboat Co	Lumber and sawdust	Not given
Board 1941	1930's	Between Middle and Puyallup Waterways on the bay	Receipt of pulpwood, chemicals, and misc. cargo - 640' pier	St Regis Kraft Co.	None	Not given
Board 1941	1930's	Milwaukee Waterway	Four wharves - 1000'l, 1020'l, other two not given	Chicago, Milwaukee, St. Paul & Pacific Railroad	Fish oil, general cargo foreign and domestic, grain storage warehouse	1.3 million gal fish oil storage - 150,000 bushels grain storage
Board 1941	1930's	Hylebos Waterway	Eight wharves - 3 for handling chemicals, 2 petroleum products, 1 for woodpulp, and 2 for lumber.	Not given	Chemicals, woodpulp, lumber	Not given

Table 9

Industry and Associated By-Products (continued)

Reference	Date	Location	Industry	Owner	By-product	Quantity
Board 1941	1930's	Hylebos Waterway - entrance in Bay	Three wharves - shipbuilding plant	Not given	Ships	Not given
P	Mid 1960's - early 1970's	Sitcum Waterway - inner end filled	First alumina storage dome constructed	Not given	Alumina storage and transfer	Not given
P	1971-1977	Sitcum Waterway - middle portion filled	Second alumina storage dome constructed - two buildings	Not given	Alumina storage and transfer	Not given

P = Photographs

4.0 DISCUSSION OF CUMULATIVE IMPACTS

Volumes of fill and/or dredge material that have occurred in Commencement Bay over the past 140 years are not consistent in the literature reviewed. Many maps, newspaper articles, and reports deal with proposed activities as well as activities that were actually undertaken. With these facts in mind, the approximate areal extent of special aquatic sites that have been altered or destroyed is given in the following section. The photographic record was used to augment written information whenever possible, and since the early photographs were taken in oblique views, the areal extent of disturbance is difficult to accurately quantify. Moreover, volumes dredged do not necessarily correspond spatially with areas filled, because dredge volumes are generally given in cubic yards and habitat loss (fills) are reported in acres. Commonly, depths of fills are unknown.

For example, when an intertidal area is dredged and the mud is sidecast, the effective habitat impact is (at the minimum) double the extent of the area dredged. This is because loss of habitat in the waterway plus the loss of habitat elsewhere should be considered; the dredged materials were sidecast or deposited in another area. If a waterway is dredged to about 30', the areal extent of the disposal site may be significantly larger than the volume removed. For example, dredged materials from the City Waterway could not be sidecast along the west bank because of steep slopes. Therefore this material could have been spread out relatively thinly over a fairly extensive area that is now the land mass between the City Waterway and the Puyallup River. This is why accurate documentation of habitat loss due to fill is lacking, (because Section 10 of the Rivers and Harbors Act deals only with dredging activities, and during the early periods details of depositions or their locations are seldom found). Although areas once filled with dredge sidecastings may have been filled repeatedly, any special aquatic habitat would have been destroyed during the initial fill event.

Thus, the figures presented in Table 10 reflect only the volume of material removed and not the areal extent of habitat loss through disposal of spoils. By 1981, according to Shapiro Associates, Inc. (in Dames and Moore 1981), 91 acres of intertidal flats, and a total of 102 acres of marsh habitat remained. Much of this habitat is probably no longer original; i.e., the habitat may have formed after the original habitat was lost. This explains the discrepancy between total number of acres lost (through documented dredge and fill volumes) and the existing number of acres of habitat remaining. For example, of the original (2,085 acres) of mudflat once thought to be present, only 566 acres of habitat loss were verifiable by non-graphical sources. Up to 1941 graphical sources (such as city maps, etc.) account for an additional 1,519 acres of intertidal mudflat. These mudflats were

affected by deposition of fills and alteration of existing habitat to open water habitat although non-graphical data supporting actual areal coverage is lacking. The same applies for the marsh habitat, and since the figure suggested by DEA (this report) is considerably higher for the presumed areal coverage of this habitat than is given by Bortleson (1980), this discrepancy is larger. Again, habitat loss in the southern reaches of the study area due to agricultural practices and residences cannot be documented. However, by 1941, when the Corps aerial stereo-pairs became available, E.M.S.L. was able to more accurately assess the amount of marsh habitat remaining. The large discrepancy in areal extent of marsh habitat is due to the conversion to agricultural lands and this is indicated in Figures 8 and 9. It is interesting to note however, that one photograph caption states, "*The last fifty-seven years has seen the Port of Tacoma grow from a 240-acre tract of barren tideflats to a prosperous industrial complex covering 4,025 acres.*" (Port of Tacoma photograph dated ca. 1978).

Table 10. Habitat Loss by Historic Period

Historic Period	Habitat Type	Non-graphical Sources of Lost Habitat	Total Lost Habitat (includes non-graphical and graphical)	Acres Remaining
1877 - 1894	mudflat marsh	11 20	0 0	2,074 3,874
1894 - 1907	mudflat marsh	208 41	605 415	1,469 3,459
1907 - 1917	mudflat marsh	51 35	542 64	927 3,395
1917 - 1927	mudflat marsh	48 0	162 72	765 3,320
1927 - 1941	mudflat marsh	143 399	133 1,676	632 1,644
1941 - Present	mudflat marsh	105 1,557	412 1,587	187 57
Totals:	**mudflat** **marsh**	**566** **2,052**	**1,854** **3,814**	

The discrepancy however, between results of E.M.S.L. (1991) GIS data and Shapiro (1981) should be answered by E.M.S.L. Specifically Shapiro reports that 91 acres of intertidal mudflat and 102 acres of marsh habitat remain while E.M.S.L. reports 187 acres of mudflat and 57 acres of marsh habitat remain. The differences may lie in potentially newly-formed special aquatic sites and mitigation areas occurring since 1981.

4.1 Indirect Impacts and Habitat Alteration Over Time

Changes in habitat structure in Commencement Bay due to development activities have occurred since the latter part of the 19th Century. Relatively little habitat alteration is considered to have occurred from about 1877 to 1900. Although the Northern Pacific railroad berm crossed the mudflats as early as 1874, its effect on habitat in the Puyallup delta is considered to be low. When South 11th Street was constructed during the first decade of the 20th century, it was probably built on pilings, and as a result, hindered the free movement of tidal and delta water only to a minor degree.

During the second decade of this century, the concurrent dredging of the waterways together with the diking of the Puyallup River, South 11th Street and Lincoln Avenue, initiated irreversible habitat changes to the delta. As discussed in Section 3.4, this alteration took the form of gradual siltation coupled with a decrease in tidal influence which changed the formerly salt marsh to a brackish marsh. Local dumping of refuse and industrial waste materials resulted in further degradation of habitat. Most of the disturbance and loss of habitat occurred in the waterways and port areas, however, during the early part of this century and as a result of the reduction in salinity of the marsh, farming and residential growth expanded northward from the upper reaches of the delta. Photographs indicate that settlements clustered near the Puyallup River and Wapato Creek. Major habitat alteration in these areas is difficult to document and in comparison to the complete loss of habitat in the port areas, habitat changes in the upper delta were minor. However, as the population of these areas increased, more marsh was filled for residences, barns, and roads, gradually fragmenting and isolating habitat (Plate 6). By 1941, large industrial development had not yet taken place in the marsh areas (Plate 7).

Although altered from its original condition (but still maintaining wetland character), the delta region suffered minor to moderate habitat loss. Wetland functions such as stormwater retention, biofiltration, and waterfowl feeding, nesting and rearing habitat were still occurring. The majority of special aquatic site loss and associated functions up to 1941 occurred in the intertidal area. By the end of the 1980's the majority of intertidal mudflat and brackish marsh had been altered, filled, and developed (Plate 8).

Plate 6

"Agriculture in Commencement Bay Area, 1955"

(Photograph courtesy of Port of Tacoma)

Obvious signs of habitat isolation and fragmentation due to agricultural practices are apparent in this photograph. Diking and draining marsh areas, and sowing these "newly reclaimed" fields with non-native pasture grasses, have significantly altered areas in the Puyallup delta.

Plate 7

"Aerial View Looking South from the Blair Waterway, 1953"

(Photograph courtesy of Port of Tacoma)

In this photograph, one sees the dredging extension of Wapato (Blair) Waterway from 11th Street to Lincoln Avenue. Original marsh vegetation is visible along the east edge of the waterway. Vegetation south of Lincoln Avenue, south and west of that waterway appears relatively undisturbed. Portions of marsh have been filled east of the waterway (shown as whitish shadings).

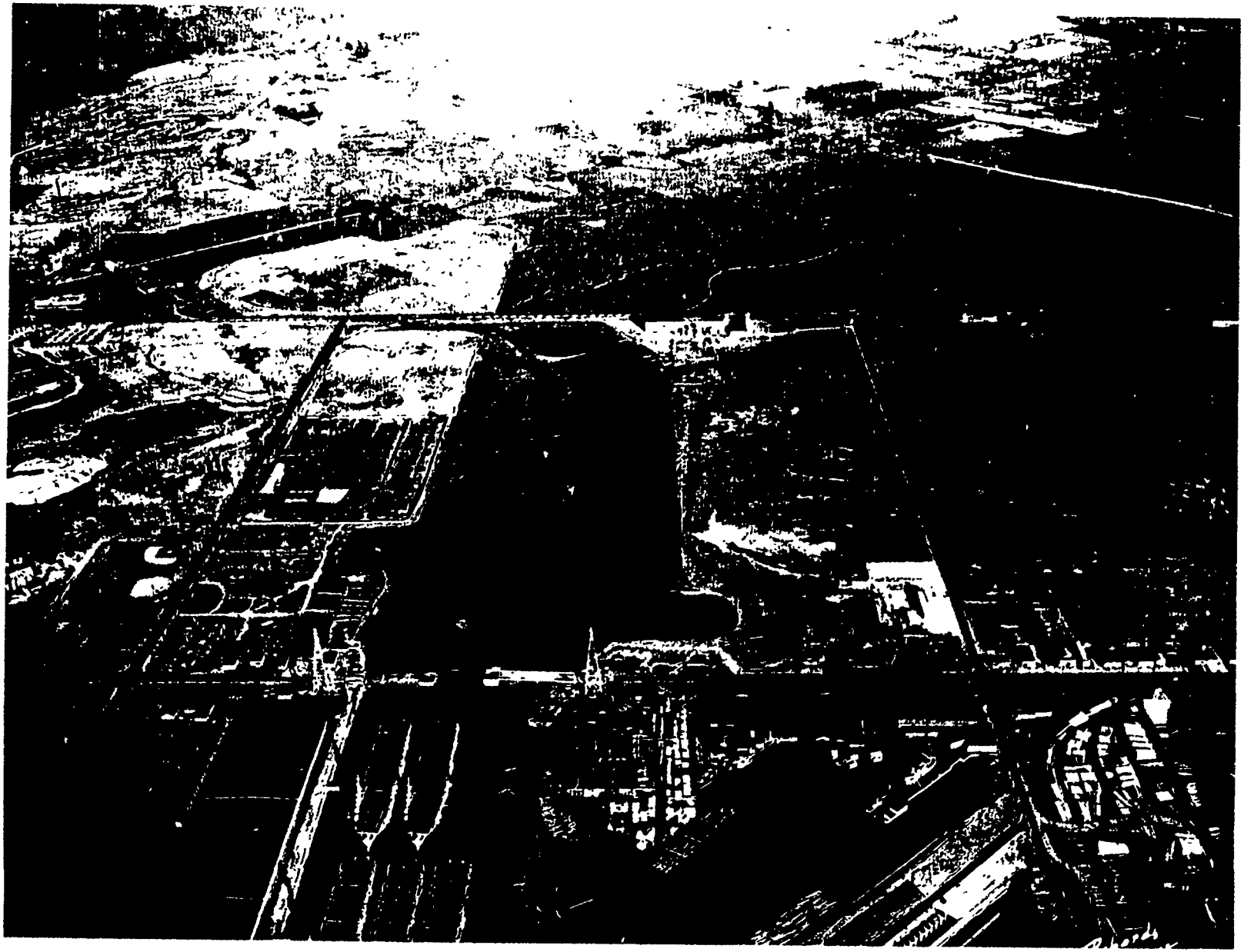
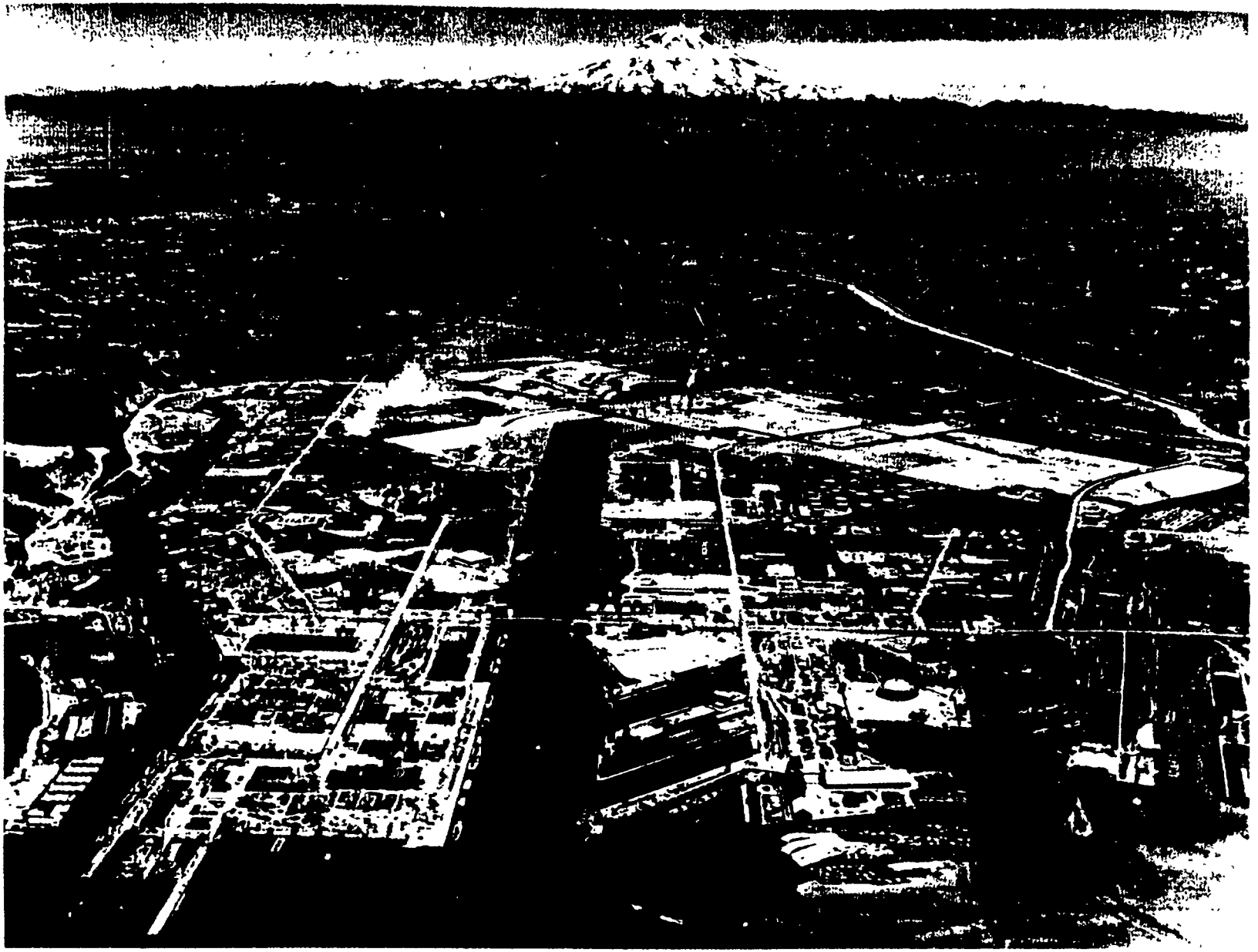


Plate 8

"Aerial View of Puyallup Delta Region, 1972"

Although not the recent photograph of the area, trends in land "reclamation" in what remains of the Puyallup River delta are visible in this aerial view. Farmlands encroach northward to the Port area as industrial use of the land moves southward. Remaining habitat is often no longer original marshland, but rather "restored" as a result of an initial disturbance followed by periods of inactivity, allowing the land to begin to revert to a wetland condition.



4.2 Trends of Habitat Loss

Early development of the Puyallup delta began in the west with the construction of Northern Pacific Railroad, St. Paul and Tacoma Mill, and City and Puyallup Waterways. Construction of 11th Street was probably concurrent. Intertidal mudflats were the first special aquatic sites to be lost. Effective changes in habitat further up-delta were beginning to become apparent as a result of human disturbance, sedimentation, and salinity alterations resulting from these port developments. In the following years, the development of the eastern portions of the delta was initiated along Hylebos and Wapato creeks. Installation of dikes, levees, and tide gates were already altering the marsh vegetation. Development progressed toward the Blair and Sitcum Waterways as well as in a southeasterly direction.

5.0 Mitigation Sites (1972-present)

Of the 212 Corps permits issued for work in the Commencement Bay area, 190 were available for review (Figure 11). Of these, 41 were considered significant (DEA arbitrarily defined significant projects as activities that either involved 5000 cubic yards or tons of material which may be dredged, filled, or both and involved filling 0.25 acre or more of special aquatic sites; or the project had some form of compensatory mitigation or habitat enhancement as a goal or condition of the permit.), of which 21 consisted of maintenance dredging in established waterways (Table 11). Nine additional permits indicated that mitigation for impacts associated with authorized work was required. Table 12 summarizes the 50 files that were considered significant. The information gathered for all permits reviewed is included in the Appendix.

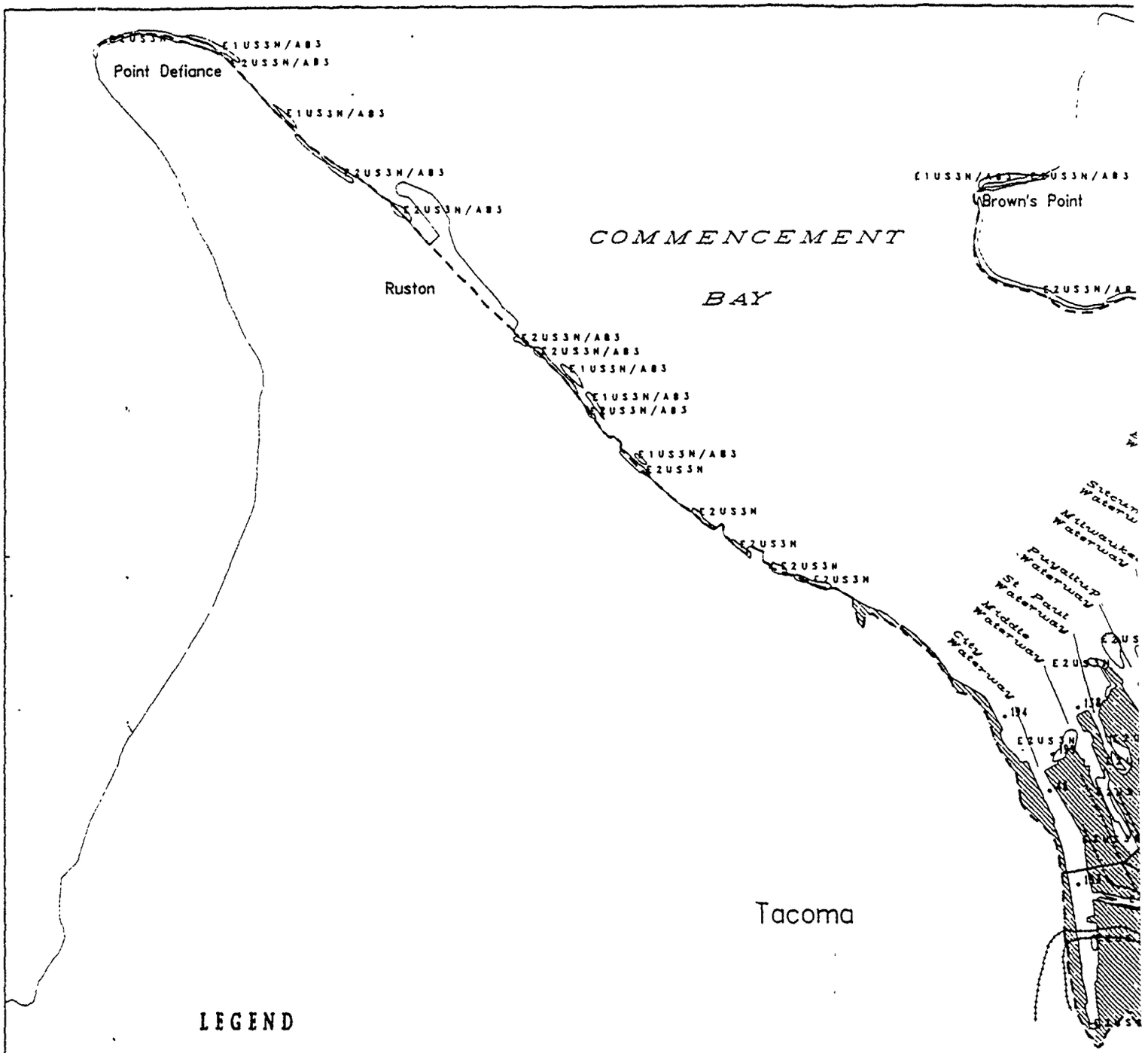
Nine individual mitigation sites have been identified in the Commencement Bay area (Figure 12) as a result of the Corps permit file review. Four of these sites are in Blair Waterway, one each in St. Paul and Middle Waterways, one adjacent to the Puyallup River, and two in Commencement Bay itself. The three main mitigation sites identified in the Commencement Bay area include the created Gog-Le-Hi-Te wetland where Lincoln Avenue crosses the Puyallup River, the Milwaukee Waterway fill, and Blair Waterway. The Corps has monitoring information on four mitigation areas including the Gog-Le-Hi-Te project, Middle Waterway, and Slip 1 and 5 of the Blair Waterway. Based on Corps reports, are all have been judged to be successful based on sampling inventories of organisms present.

Sampling for organisms has not been long-term and therefore the results while promising, are not conclusive. The three beach creation projects are described in the following paragraphs.

The **Gog-Le-Hi-Te Wetland** is an approximately ten-acre site created by breaching the berm on the east bank of the Puyallup River and constructing a new berm somewhat further from the river. The newly inundated area was graded and planted with Lyngbye's sedge (*Carex lyngbyei*). This site was monitored by the University of Washington School of Fisheries after construction was completed in 1986, and has been acquiring natural wetland features, that support myriad aquatic, terrestrial, and avian species (Thom et al. 1988, 1990).

The **Middle Waterway** was mitigation for file 51 and was constructed in 1983. The benthic infauna of the salmon enhancement area were sampled in 1985 to determine whether a food chain of benthic organisms was established on the modified beach. Results of the survey showed were positive, with samples containing a diversified population of benthic species, with some significant number of individuals per species (Johnstone, 1985).

The **Milwaukee Waterway Fill** is intended to create approximately 15.6 acres of intertidal and shallow subtidal habitat from former deep water habitat (Port of Tacoma, date unspecified). The fill was intended to be acquired primarily from the Blair navigation channel and from some berth areas as part of the Blair-Sitcum Waterway Improvement Project, authorized by the United States Congress in 1986, and partially from off-site sources such as Steilacoom (Ogden Beeman, 1990). In addition, some material for this fill was dredged from the Puyallup River itself. Approximately 2,203,000 cubic yards (cy) of fill material from various sources will eventually be used in this project, of which 605,000 cy is specifically for the fish mitigation area. The proposed mitigation involves creation of an intertidal beach (about 8.4 acres), construction of transitional intertidal slopes between the beach and existing intertidal flats, construction of a shallow subtidal flat, and placement of fill. Approximately 13,600 cy of fill was permitted to be placed by the Port of Tacoma into Milwaukee Waterway under permit numbers 071-OYB-10008374 and 071-OYB-20007015. Not all of the work authorized by the former permit was completed prior to permit expiration. It was not clear from the files whether these two fills were related to the mitigation project.



LEGEND

- Open Water
- Intertidal Mudflat
- Intertidal Emergent Marsh
- Forested Upland
- Unclassified Area
- Fill
- Study Area Boundary
- Interstate 5

N

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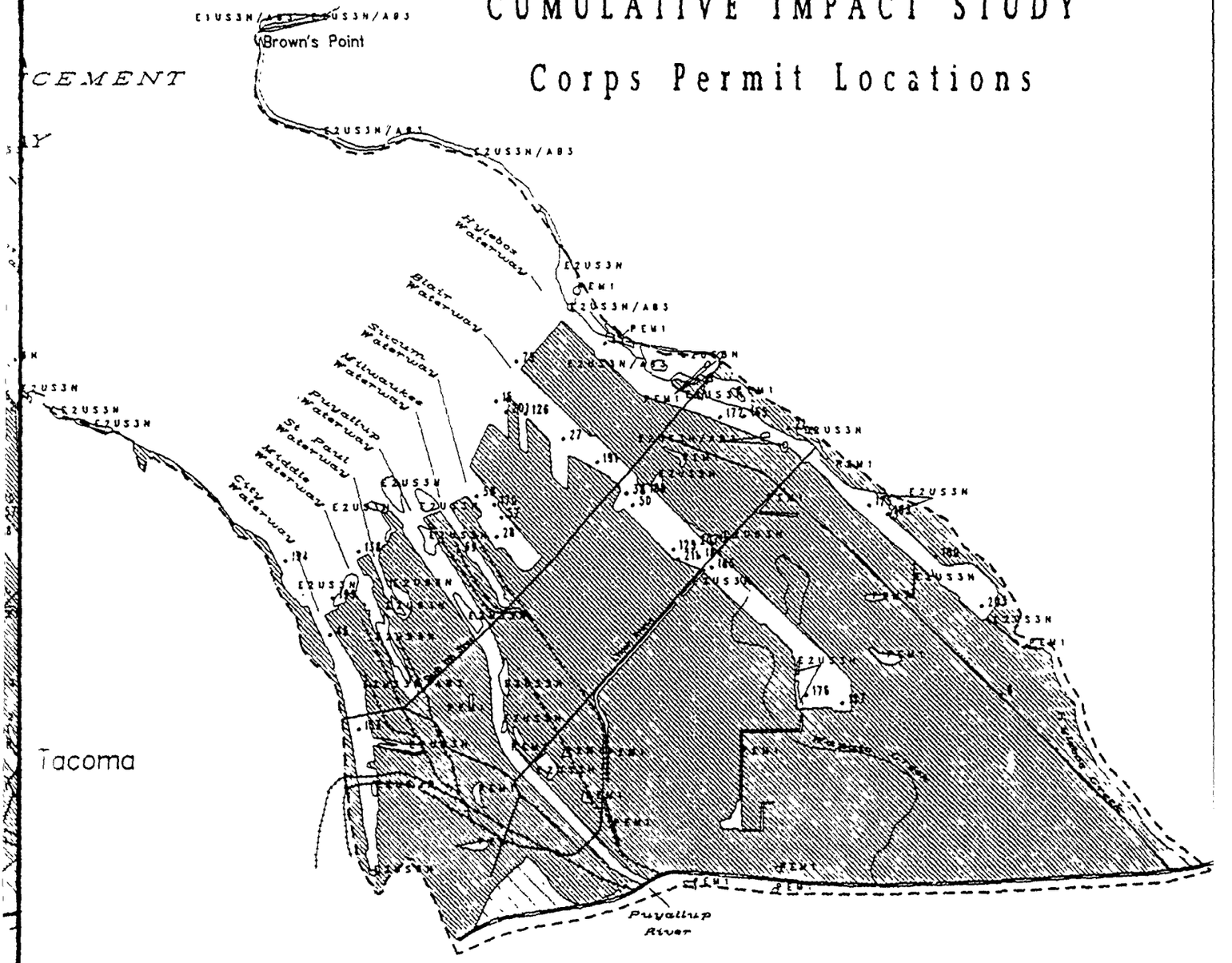
Scale 1:24000

Source: USGS

COMMENCEMENT BAY 1988
CUMULATIVE IMPACT STUDY
Corps Permit Locations



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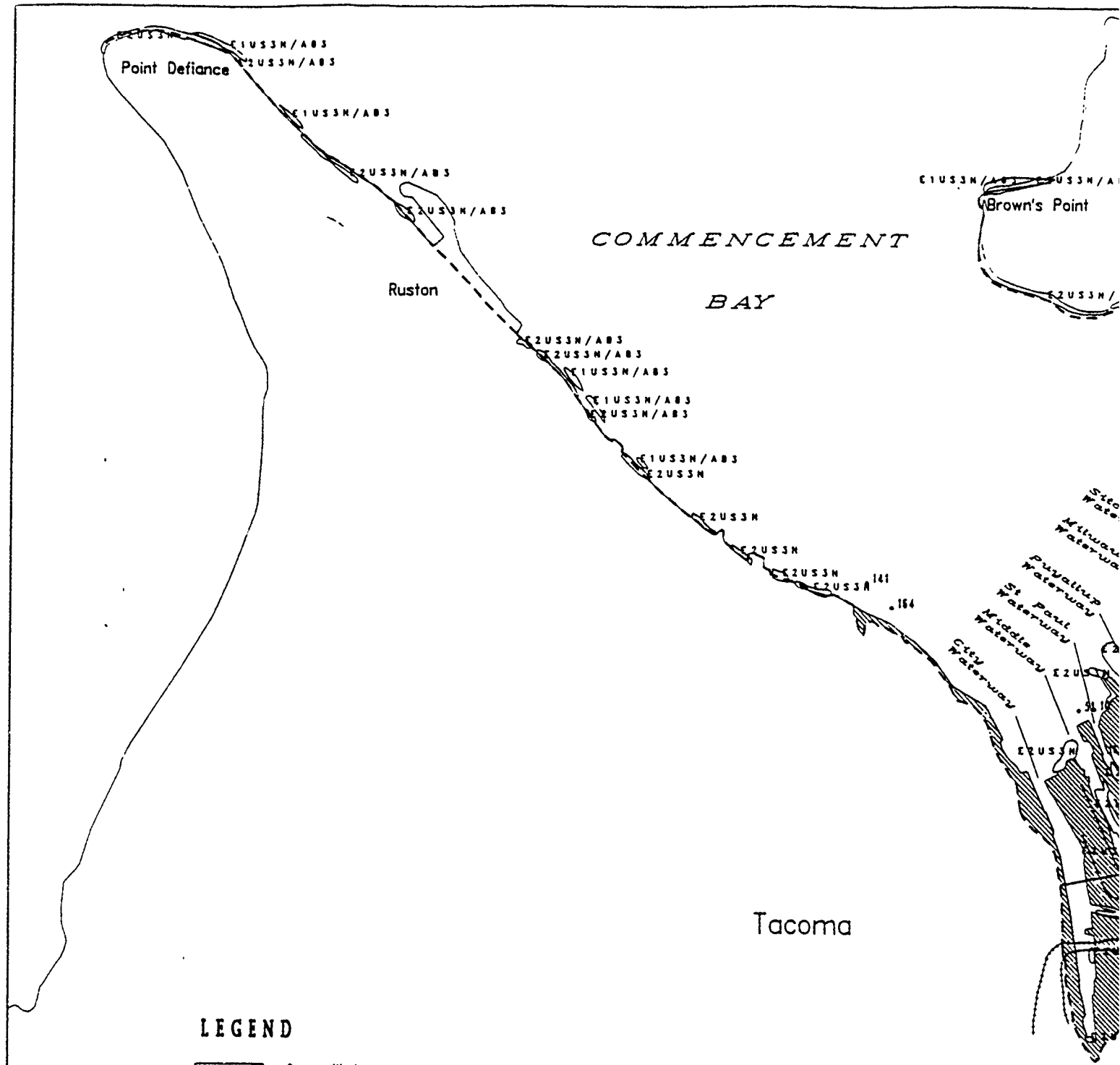
Source: USGS 1981 (7.5 minute series), Bortleson et al 1980 and E.V.S.L. 1991

Figure 11



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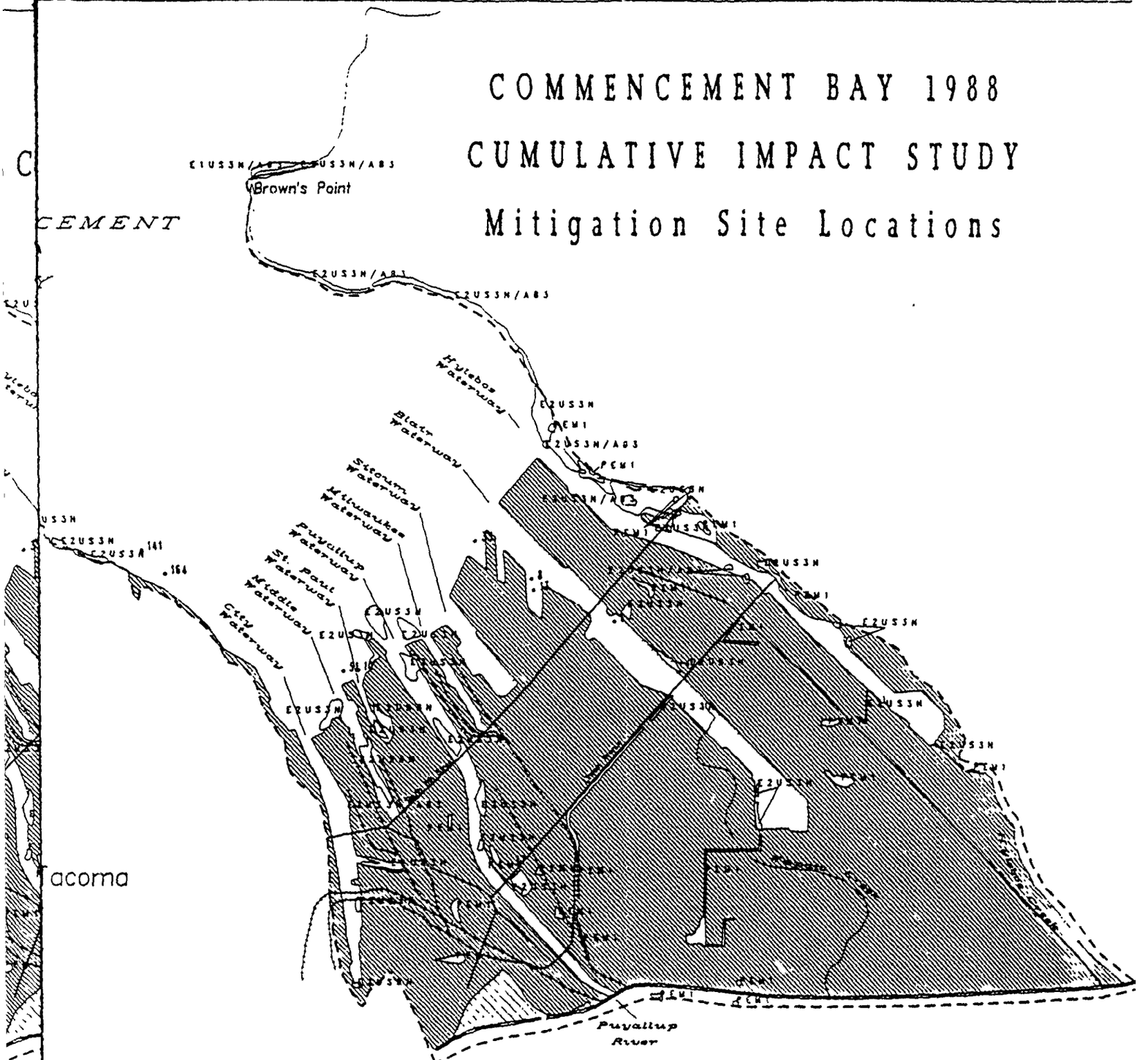
Landscape Architects, Scientists

Source: US

COMMENCEMENT BAY 1988
CUMULATIVE IMPACT STUDY
Mitigation Site Locations



Scale 1:24000

Source: USGS 1981 (7.5 minute series), Bortleson et al 1980 and E.M.S.L.1991

Figure 12

The mitigation in **Blair Waterway** will be confined primarily to conversion of 2.7 acres of intertidal fish habitat to shallow subtidal and deep water habitat (Jones and Stokes 1990) in slip five, with small areas also in slips one and two. In addition, work was conducted as preparation for future fisheries mitigation projects in slip five. Additional mitigation for impacts in Blair is also proposed in Milwaukee Waterway as part of the Milwaukee Waterway Fill and Fisheries Mitigation Project (Jones and Stokes 1990). Proposed mitigation for impacts in Blair include removal of contaminated sediments from intertidal slopes and placement of rip-rap and gravel as a substrate for epibenthic zooplankton. Some mitigation for impacts in Blair Waterway may also occur in the Milwaukee Waterway. As a modification to the mitigation proposal for Milwaukee Waterway, the proposed slope of the beach area of the Milwaukee mitigation will be changed from 12H:1V to 16H:1V, resulting in a greater proportion of intertidal habitat with less shallow subtidal habitat.

Monitoring of the Blair and Milwaukee mitigation plans is proposed to consist of physical and biological sampling of the mitigation habitat and comparison to a reference site to determine compliance with the environmental goals of the project. Although the ultimate gaol of the project is to increase salmonid abundance, the monitoring program will focus on evaluation of habitat quality because of sampling difficulties and annual variability of fish populations. Monitoring will be conducted for three years after construction. Physical monitoring will begin immediately, and biological monitoring will begin one year after construction is complete to allow colonization by prey organisms and continue for 2 years.

The Blair and Milwaukee Waterways dredge, fill, and mitigation projects are interrelated due to the Puyallup Settlement Agreement, effective March 24, 1990. The Port's objective is to increase capacity and efficiency of an existing marine terminal by filling Milwaukee Waterway and to implement the Settlement Agreement. Placement of Blair dredge material into Milwaukee Waterway as fill is specified by the Settlement Agreement and its implementing legislation (Port of Tacoma, date unspecified). The Milwaukee Waterway Fill and Fisheries Mitigation Project and the Blair Waterway Navigation Project are specifically addressed in the Settlement Agreement, and have specific conditions and mitigation requirements.

St. Paul Waterway mitigation was incorporated as part of a permit issued to the Simpson Tacoma Kraft Company. It consisted of excavating 6,000 cy of contaminated material from the waterway, constructing a closure berm and capping the entire waterway with 300,000 cy clean sand and gravel from the Puyallup River. The activity was meant to correct the problem of sediment contamination and to create substantial new intertidal habitat for bird and marine life. This work was authorized in December 1987 by permit number 071-OYB-2-011576. There was no indication in the file whether the work had been completed as designed.

Mitigation in **Middle Waterway** was intended to enhance 0.93 acre of existing salmon habitat and re-establish the food chain. The existing bank received minor modifications including placement of bank run, clean dredge spoils and rip-rap. In addition, some of the existing bank was cut back and mixed with new fill to be placed below the mean lower low water mark as part of the mitigation. The permit for this work was issued in January 1983. The file did not indicate whether the work was completed.

Both of the mitigation projects in **Commencement Bay** proper attempted to improve fish habitat by constructing reefs from old rubber tires. This work was authorized by two separate permits, one issued in July 1975 and the other in May 1977. No documentation was found on the outcome of either of these projects.

Table 11

Summary of Significant Permits for Shoreline Alterations 1972 to 1990

File[1]	Work	Mitigation
6	excavate 3,200 cy limestone waste from Blair; place 1,200 cy rip-rap	3/8" gravel blanket, transplant marsh vegetation
8	dredge 71,000 cy material from Blair, deposit in slip 5 to form buttress for future fish habitat mitigation	fish habitat enhancement
9	fill 0.28 acre wetland adjacent to Hylebos Creek with approx. 2,040 cy	none
10	dredge 6,000 cy contaminated material from St Paul, place 26,600 cy sand, gravel and rip-rap, dredge 300,000 cy sand and gravel from Puyallup River for berm and landfill cap	create intertidal habitat for birds and marine life
13	dredge 167,000 cy from Blair; deposit 92,000 cy into slip 2, 75,000 cy into slip 5; 121,000 cy upland fill used to cap, 21,000 cy construction rubble; 35,000 cy upland fill for support berm for wharf	create 2.7 acres intertidal fish habitat in slip 5
15	dredge 25,000 cy from Blair	none
21	retain 10,000 cy illegal fill in Hylebos, place additional fill	none
27	dredge 35,750 cy material from Blair	none
33	dredge 730 cy, place 4,300 cy in Blair, slip 1	create 5,600 sf fish mitigation area (mitigation for file 38)
37a	retain 1,000 cy and place add'l 40,000 cy in Puyallup River	create 12-acre freshwater tidal wetland
38	dredge 58,000 cy from Blair, place 6,000 cy rip-rap	mitigation required, see file 33
45	dredge 270,000 cy material from Blair, place 7,620 cy rip-rap	none
46	dredge 5,000 cy material from City	none
50	dredge 25,000 cy over 5 years from Blair	none
51	place 32,000 cy fill in Middle	enhance 735' x 55' area, place 11,650 cy bank run and clean dredge spoils for salmon
58	remove 41,000 cy sand and mud from Sitcum	none
57	dredge 19,000 cy from Sitcum	none
69	place 11,200 cy clean granular fill in Milwaukee from upland source; place 900 cy rip-rap	none
75	remove 18,000 cy old fill (upland disposal), piers, and replace pile caps and runners in Blair	none
82	excavate 3,270 cy material, place 14,900 cy fill in Commencement Bay	none
86	place 4,340 tons rip-rap and bedding material, excavate 3,000 cy material from Commencement Bay	none
100	excavated 5,500 cy from Hylebos; place 140 cy fill	none
103	dredge 9,600 cy silty material from Hylebos	none
123	maintain existing slag fill and place additional 863,393 cy slag fill in Commencement Bay	none

Table 11

Summary of Significant Permits for Shoreline Alterations (continued)

File[1]	Work	Mitigation
125	place 10,000 cy bankrun sand and gravel; dredge 50,000 cy sand and silt; place 5,750 cy rip-rap and 3,850 cy gravel for wharf in Blair	none
126	place 600,000 cy silty sand fill; 18,000 cy of 12" quarry spalls for berm; 50,000 cy bankrun sand and gravel in Blair slip 2	none
127	dredge 17,000 cy from Blair, place 6,500 cy gravel and rip-rap	none
128	remove 214,000 cy material from Sitcum, place 144,000 cy slag, 374,000 cy sand	none
134	excavate 90,000 cy slag from Commencement Bay and place 30,000 cy broken slag rip-rap	none
138	construct seawall and fill 0.40 acre intertidal wetland at end of St Paul/Middle peninsula	none
141	install reef, place 1,200 cy washed paving sand in Commencement Bay	improve marine habitat
153	dredge 4,570 cy material from City, place 1,400 tons rip-rap	none
161	open-water disposal of 95,000 cy material dredged from Hylebos under file 165, permit 1-002550	none
164	construct two underwater reefs in Commencement Bay out of old tires	improve fish habitat
165	dredge, place rip-rap in Hylebos (see file 161)	none
170	dredge 125,000 cy silt and sand w/upland disposal; place 9,500 cy rip-rap and 9,500 cy gravel in Sitcum	none
172	dredge 10,600 cy sand, mud, and gravel from Hylebos	none
175	dredge 5,000 cy material from 400' x 75' area in Commencement Bay (upland disposal)	none
176	dredge 100,000 cy sandy silt (upland disposal), place 5,000 cy rip-rap in Blair	none
184	dredge 300,000 cy silty sand and gravel from Blair (upland disposal)	none
185	place 6883 cy broken concrete, 4588 cy concrete and granular material in Blair	none
189	excavate 500 cy concrete rubble, face bank with 4,500 cy concrete and rip-rap in Blair	none
191	dredge 60,000 cy silty sand and gravel (upland disposal), 4,000 cy rip-rap and granular material (open-water disposal) from Blair	none
192	construct bulkhead of 10,000 cy broken concrete; place 4,000 cy sand, bricks and rock and 20,000 cy bankrun sand and gravel in Commencement Bay	none
194	place 5,250 cy backfill for storage facility in Commencement Bay near C[illegible]	none

Table 11

Summary of Significant Permits for Shoreline Alterations (continued)

File[1]	Work	Mitigation
199	dredge 7,000 cy silt and bark at end of City/Middle peninsula	none
201	dredge 15,000 cy sand and silt (open-water disposal) from Blair near slip 2	none
203	dredge 35,000 cy mud (open-water disposal) from Hylebos	none
207	place 4,000 cy gravel and 1,500 tons rip-rap in Blair	none
211	dredge 16,500 cy sandy silt (upland disposal) from Blair	none

Table 12

Summary of Significant Projects, Sorted by Location

	Dredge (cubic yards)	Fill (cubic yards)	Impact[1] (acres)	Mitigation[1] (acres)
City Waterway	15,050	1,984	0.12	---
St. Paul Waterway	6,000	26,600	---	---
St. Paul/Middle Peninsula	---	2,700	0.40	---
Middle Waterway	---	32,000	---	0.93
Puyallup River	300,000	41,000	---	~10[2]
Milwaukee Waterway	---	13,600	---	---
Sitcum Waterway	345,500	537,000	---	---
Blair Waterway	1,883,830[3]	386,200	---	2.83
Hylebos Waterway	92,700[3]	19,670	0.35	---
Commencement Bay	122,070	936,125	---	---
TOTALS[4]	2,765,150	1,972,939	0.87	15.76

1 Most files had no information on square footage; these columns total only those that had data.

2 Gog-Le-Hi-Te wetland creation.

3 Blair Waterway - approximately 250,000 cy dredged from one area and redeposited in Blair, mostly into Slip 2. Hylebos Waterway - 4,100 cy dredged from and redeposited into Hylebos.

4 The difference between the dredge and fill amounts is due to the placement of some dredge material in either upland locations or deepwater disposal. These quantities were not tracked because they did not affect nearshore habitat.

6.0 ACKNOWLEDGEMENTS - STUDY TEAM

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APPENDICES

APPENDIX A:

TRUSTEES FOR COMMENCEMENT BAY
COMPREHENSIVE HABITAT MITIGATION AND RESTORATION

A COMPREHENSIVE HABITAT MITIGATION AND RESTORATION PLAN FOR COMMENCEMENT BAY

Three major regulatory processes have resulted or will result in mitigation and restoration of natural resources in Commencement Bay. The first of these is mitigation of wetland habitats required by the Corps of Engineers under Section 404 of the Clean Water Act. When Federally permitted dredge and fill projects in navigable waters result in loss of wetlands, the public must be compensated for that loss by mitigation. The second regulatory process is site clean up under the Environmental Protection Agency's Superfund program. Clean up of contaminated marine sediments within the Commencement Bay Nearshore/Tideflats Superfund site will include requirements for remediation. The third process is damage assessment through the use of the U.S. Department of the Interior's Damage Assessment Regulations (43 CFR Part 11). Natural resource trustees acting on behalf of the public are required to determine damages (in dollars) to natural resources injured by the release of hazardous substances (as defined under CERCLA or the Clean Water Act). Monies recovered from polluters for these injuries must then be spent on restoration, replacement, rehabilitation or acquisition of the equivalent reso. .ces.

To date, a relatively small number of Corps permitted projects requiring wetland habitat mitigation nave occurred in Commencement Bay. The number is expected to increase as mitigation becomes the rule rather than the exception. Mitigation for both past and future projects may be considered piecemeal in that no overall scheme for mitigation/restoration that considers both the heavily industrialized nature of portions of the bay as well as its importance as habitat for salmonids and other resources exists.

Under EPA's Superfund program, site clean up of intertidal, nearshore, and subtidal contaminated sediments within the Nearshore/Tideflats site will require those sediments to be suitable substrate for indigenous biota. In addition, any in-water or nearshore sediment disposal sites will include habitat mitigation, as appropriate. Clean up will proceed on a waterway by waterway basis as source control is implemented through the 1990s.

Beginning in 1990, the tribal and governmental natural resource trustees for Commencement Bay (Puyallup Tribe of Indians, Muckleshoot Indian Tribe, Washington Department of Ecology, Washington Department of Fisheries, Washington Department of Wildlife, Washington Department of Natural Resources, National Oceanic and Atmospheric Administration, and U.S. Department of the Interior) will be assessing damages to natural resources due to releases of hazardous substances within the Commencement Bay Nearshore/Tideflats Superfund site. It is expected that damages will be significant. As part of the damage assessment process, a habitat restoration plan must be developed.

It is proposed that the regulatory, scientific, and trustee (governmental and tribal) agencies combine resources to develop a comprehensive plan for habitat mitigation and restoration of natural resources in Commencement Bay. It is envisioned that such a plan will identify those areas of the bay where restoration will have the greatest benefit to both targeted resources of concern (salmon, e.g.) and the overall bay eco-system. The plan would necessarily be integrated with all other related projects- for example the $10 million fisheries enhancement project for Commencement Bay to be funded as part of the Puyallup Tribe's land claim settlement. Such a plan would allow the wisest allocation of dollars spent on mitigation and restoration. By focusing on key areas in Commencement Bay where mitigation and restoration will provide maximum benefit, a comprehensive plan can best serve the public interest.

Draft - 5/4/90
L. Consiglieri

CENPS-OP-RG

24 December 1990
(revised)

STATEMENT OF WORK

COMMENCEMENT BAY CUMULATIVE IMPACT STUDY

HISTORIC REVIEW OF SPECIAL AQUATIC SITES

1. Introduction. Under the authorities of Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act the U.S. Army Corps of Engineers regulates activities in our nation's waters. In the past several months, regulation of activities in Commencement Bay have become increasingly complex. Several factors have combined which complicate permit evaluation. These factors include:

A. The designation of the Commencement Bay Nearshore/Tideflats Superfund site. The ROD for this site has noted four methods of remediation for contaminated sediments, by far the most logistically attractive of these is near shore fill. The expected volume of clean up material is about a one million cubic yards. For cleanup activities requiring nearshore fill, habitat mitigation will be a requirement.

B. The reactivation of the Milwaukee Waterway Fill project. This is a 24 acre fill that will take up about 75% of the waterway.

C. The Puyallup Settlement, a agreement between the Puyallup Tribe of Indians and various federal, state and private parties, which has identified certain work to be performed in the Bay by the Port of Tacoma.

D. Navigational needs (maintenance dredging) that will continue in non-Superfund waterways.

E. Under the Superfund legislation a "Trustee Committee" has been created that will develop a comprehensive plan for habitat and restoration of natural resources in the Bay .

A portion of the permit review process for activities in Commencement Bay includes the 404(b)(1) Guidelines, used to evaluate the discharge of dredge or fill material into waters of the United States. Fundamental to these Guidelines is the precept that dredge or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystem of concern. From a national perspective, the degradation or destruction of special aquatic sites is considered to be among the most severe environmental impacts covered by the Guidelines.

Three types of special aquatic sites presently exist in Commencement Bay:

* mud flats, (these are broad flat areas along the sea coast and in coastal rivers to the head of tidal influence),
* vegetated shallows (permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as turtle grass and eelgrass in estuarine or marine

not duplicate the efforts already contained in Dames and Moore, "Commencement Bay Study Environmental Impact Assessment" I (12/81) and II (4/83) and the "Puget Sound Environmental Atlas."

6. Corps of Engineers Responsibilities. The Corps of Engineers will provide the following data sources:

A. Commencement Bay Study Environmental Impact Statement I and II

B. Puget Sound Environmental Atlas for Commencement Bay

C. A letter of introduction of study purpose, as appropriate.

D. Access to Regulatory Branch files pertinent to the project.

E. Digitized basemap of Commencement Bay on disk in ARC INFO format

F. Access to historic aerial photos, as needed

G. Other documents as necessary.

7. Study Overview. The entire project will be a combined study involving the Environmental Protection (EPA), the U. S. Fish and Wildlife Service (USFW), National Oceanographic and Atmospheric Administration (NOAA) and the Corps. The Corps portion of the study, undertaken principally by this contract effort will be outlined in the next paragraphs. The overall scope of the project follows:

A. Conduct a comprehensive literature/library/archival map search to identify the historical extent and locations of special aquatic sites in Commencement Bay. Site locations and maps will be graphically reproduced onto an existing GIS data base. Conduct a search through regulatory branch files to determine extent of dredging and filling that has occurred in the past in Commencement Bay. This search will also identify areas within the Bay that are used as mitigation for these activities. Provide a narrative summary of the history of shoreline development throughout the historic period, specifically identifying the locations of particular industries and their associated by products. This portion would be conducted by the Corps under this contract.

B. Using remote sensing techniques to evaluate the photographic record for Commencement Bay to: identify, spatially locate and ascertain the extent of special aquatic sites (USFW's Classification of Wetlands and Deepwater Habitat may be used to categorize these habitats). Changes in size and distribution will then be observed over time, this information will also incorporated into the GIS data bank at EPA. This portion of the study will be performed by EPA. Additionally EPA will coordinate with Washington Department of Natural Resources and obtain data pertinent to the study.

C. A trend analysis identifying population and distribution changes through time of indicator species, aquatic species of financial import, and prey species or other aquatic species critical to the food web. In addition, specialized habitat essential to the preservation of said species will be identified and mapped. This aspect of the study would best be conducted by USFW, with NOAA providing technical assistance when needed with resulting graphics to be incorporated into the GIS

(5) A copy of Blomberg, Simenstad and Hickey's study of the Duwamish estuary is included as an attachment to this scope of work and should be used a model in formulating the narrative, chronoloyg, and mapping for this study. In addition, however, we want documentary historical photos of aquatic habitat quality where this might exist.

B. Work Products: The result of the search will be a written narrative report summarizing results, containing maps and appropriate photos, and copies of historical maps that are to be incorporated into the GIS data bank depicting the overall results of the search.

C. The Contractor is responsible on behalf of the Corps, for coordinating actions between itself and the other participating members (EPA, USFWS, and NOAA) of the study team so there is no duplication of effort during the investigational portion of the study.

9. Report

A. The report will result from the Corps contracted portion of the study. The context of which have been outlined as Item 1 (literature/library report). Analytical rather than encyclopedic coverage is requisite. A bibliography of references cited and material consulted will be included.

B. The contracted literature/library report will include up to five (5) maps depicting the best estimate at the end of each selected study subperiod of special aquatic sites that were present in the bay at that particular time and one map of existing mitigation sites. Where possible, the USFW's Classification of Wetlands and Deepwater Habitat should be used. Dated historical photos are encouraged. In cases where historical data are not detailed, a range of acreage covered can be substituted, with the maps showing the middle range of the estimate and dashed lines to show that the extent of the aquatic sites might be more or less. The maps will be suitable for digitization at a scale designated by the Corps of Engineers. Each map will be digitized onto the Commencement Bay map (supplied by the Corps) and consist of an historic base map and an overlay indicating the extent of the special aquatic sites at the time of record. The exception is the map showing mitigation sites which will consist of a present basemap (designated by the Corps of Engineers) and an overlay showing the the existing mitigation sites. One set of presentation maps (approximately 3 feet by 3 feet) will be provided to the Corps of Engineers as well as 11 x 17 inch format maps for the report.

C. Both draft and final reports shall be prepared on standard 8 1/2 x 11 inch paper, and bound with ACCO fasteners or similar binding device (three copies of each draft and final reports shall be provided to the Corps).